

SCIENCE



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Contents

George William Scarth: 1880-1951; J. Levitt
News and Notes
ivews and ivotes
Technical Papers Birefringent Stepgauge: Katharine B. Blodgett
An Observation on the Infrared Absorption Spectrum of Dextran: Stanley C. Burket and Eugene H. Melvin
An Ultramicronutritional Bio-Assay Technique Employing Seeded Agar Tubes: Maurice E. Shils et al.
Effect of Wind-generated Waves on Migration of the Yukon River in the Yukon Flats, Alaska: John R. Williams
Crystalline Visnagan: Eric Smith, L. A. Pucci, and W. G. Bywater
Association of Enzymatic Activity with Submicroscopic Particles: Alton Meister
Membrane Resistance Changes in the Course of Axonal Spike Modified by Low Na ⁺ Concentration: Harry Grandfest et al.
Blood Transfusion in Irradiation Hemorrhage: J. Garrott Allen et al.
Comments and Communications A. J. Carlson, Leonard Haseman, F. Hoelzel, Arthur L. Kelly Don R. Mathieson, Carl H. Oppenheimer, D. Perlman, and Ruth A. Seale
Book Reviews Essay in Physics; Microbial Decomposition of Cellulose; The Sucking Lice
Scientific Book Register
Scientists and the NSF
Mastings & Conference

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Scientists and the NSF

N MAY 10, 1950, the President signed the bill which thereby became the National Science Foundation Act of 1950. This marked the beginning of a new chapter in the history of science in America. The act established an instrumentality which, if adequate support for its activities is provided, can effectively work toward the realization of the ideals and objectives set forth in the Bush report, Science the Endless Frontier, published in July 1945.

The operating agency, as distinguished from the National Science Board, completed its first year on April 6, the anniversary date of the appointment of Alan T. Waterman as director. Its operations during the present fiscal year are on a necessarily modest scale with a budget of \$3,500,000. Within the limitations thus set, activities are under way in assembling the staff to carry out the prescribed functions, to develop policies through the National Science Board, to prepare plans and procedures by which the staff may best accomplish its tasks, and to establish the support for basic research and education in the seiences through grants and fellowships.

There is strong emphasis in the act, and in the activities to carry out its provisions, on fundamental research with complete freedom of choice-research motivated by intellectual curiosity. Being a federal agency specifically directed by statute to support basic research and education in science, one of its most important purposes is to assure that we shall add substantially to knowledge of all the sciences, the extent of which so profoundly affects our economy, our security, and our social structure.

The foundation was created for, and belongs to, the people of the United States. It is in its infancy. Its nurture is the duty of scientists, so that it may realize its potentialities, and become the means for maintaining and increasing our sources of fundamental knowledge. Scientists who believe in this impressively conceived experiment can help achieve success by keeping themselves reminded, and acting upon their convictions, that much of the support of science comes from the public through its legislative bodies; and that the support of the foundation comes specifically by way of annual appropriations made by the Congress.

Sustained and continuous education of the public and of its representatives on the significance of seience and on the purposes of the National Science Foundation is essential in a country such as ours, where applications of science play so vital a part in everyday life. The task of the National Science Board and the foundation's staff will be greatly eased and the results of their efforts more fully assured if seientists will consider it their duty to participate in these educational activities. Such an endeavor is logically a part of the broader objective of bringing the knowledge of science to the public which, in the Arden House statement regarding the future of the AAAS, is declared to be an essential activity of scientists in the United States.

Ours is a practical-minded nation. It has become increasingly so through the technological successes prior to and during World War II. Developments out of existing knowledge cannot go on indefinitely without replenishment of the store of knowledge. There is possibility, indeed probability, that if, as now, most of our scientists apply their genius primarily to practical ends, we shall find ourselves drifting into a situation in which we may be thwarted as creators of knowledge. We may lose the cultural values that are inherent in the science areas of learning.

Preserving these values is as much our business as is our professional occupation in the classroom and the laboratory. The medium of accomplishment, the National Science Foundation, is at hand. Its future depends on the scientists of the country.

PAUL E. KLOPSTEG

National Science Foundation

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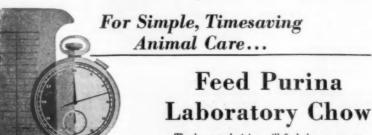


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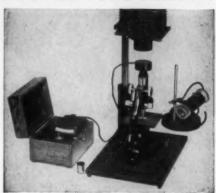
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Scripps Institution of Oceanography, University of California, La Jolla

ACTERIA IN ABUNDANCE have been found (1) in virtually all samples of marine bottom deposits, examined regardless of the depth of the overlying water. Until recently, however, very few samples had been taken from depths exceeding 2000 meters, and none from little more than half the depth of the most abvssal oceanic deep. Certes (2) reported the presence of bacteria in bottom deposits collected on the Talisman Expedition from depths as great as 5100 meters. Significantly, Certes (3) observed that the organisms from around 5000 meters were able to tolerate hydrostatic pressure approximately isobaric with this depth; namely, 500 atmospheres. On the Humboldt Plankton Expedition to the West Indies, Fischer (4) found bacteria in several deep-sea sediment samples, 5280 meters being the greatest depth that he explored. Marine microbiologists at the Scripps Institution recovered bacteria from mid-Pacific mud at a depth of 5300 meters (Lat. 14° 22' N, Long. 133° 06' W) and in a sample of bottom deposits collected off the coast of Bermuda from the floor of the Atlantic Ocean at a depth of 5800 meters.

Recently the Danish Galathea 'Round the World Deep Sea Expedition has afforded facilities for the collection and microbiological analysis of sediment samples from the deepest known parts of the oceans. Many samples were taken from depths exceeding 6000 meters, including several from the Philippine Trench at depths greater than 10,000 meters. Confirming and further delineating the observations of the U.S.S. Cape Johnson (5), this trench was shown by echo depth recorder to extend for about 100 miles from 9° 04' N×127° 05' E to 10° 41' N×127° 37' E on a line about 20° west of north. For most of its length its walls rise precipitously from the bottom, which is only from one-half mile to three miles wide. Only by the best of navigation was it possible to delineate

¹ Contribution from the Scripps Institution of Oceanography, University of California, New Series No. 570. It is also a contribution from the Danish Galathea Deep Sea Expedition 1950-52.

pedition 1950-52.

³ This investigation was supported in part by grants from the Research Committee of the University of California (Grant No. 1250) and the Office of Naval Research (N6on-27518). Acknowledgment for invaluable assistance is accorded to Anton Fr. Bruun, leader of the Galathea Expedition, and to all the hundred men on the ship, who contributed in many ways toward the success of the investigations, Special thanks are due to ship's physician, Comdr. Tage Feddersen, and Captain Sven Greve, Torben Wolff, Poul Jacobsen, Alf Kielerich, and P. Andreasen.

the trench and to stay on station from 8 to 18 hours, the time required to collect a sample from the bottom. Often this was achieved in the face of adverse meteorological conditions characteristic of the monsoon and typhoon season in Philippine waters during

July and August 1951.

Samples of bottom deposits were collected by means of a plastic-lined Kullenberg corer and a Petersen grab. Immediately after they were brought to the surface, radially central samples were removed with sterile instruments to secure uncontaminated material for microbiological analysis. The direct microscopic method and several standard cultural procedures were employed to demonstrate the presence of bacteria. Duplicate cultures were incubated in the ship's refrigerator at 2.5° C, which approximates the sea floor temperature, and at air temperature, which varied little from 30° C. Part of the cultures were incubated at atmospheric pressure and part in steel cylinders (6) at approximately the pressure of the environment from which the inocula were collected. Representative findings for five samples from the Philippine Trench are summarized in Table 1. For comparison the results from two samples taken from lesser depths on either side of the trench are presented. Sea water enriched with peptone, beef extract, and yeast extract was employed as the culture medium.

Table 1 shows the number of bacteria demonstrated in the topmost layer of bottom sediments by the minimum dilution method. The abundance of bacteria was found to decrease sharply with depth below the mud-water interface. Only 10 to 100 viable cells could be detected per gram of mud from depths 75 to 100 cm below the surface of the sea floor. All cultural counts must be regarded as minimal, however, because no one medium or set of cultural conditions could conceivably provide for the reproduction of all bac-

teria.

The presence of large numbers of bacteria in bottom deposits was confirmed by the direct microscopic observation of freshly collected samples. Direct microscopic counts, however, had little quantitative significance, owing to the difficulty of distinguishing particles of sediment from bacteria, and other practical difficulties caused by vibration and other movements of the ship at sea.

The largest cultural counts were obtained in nutrient medium incubated at around 2.5° C. It is also

TABLE 1 NUMBER OF BACTERIA PER GRAM WET WEIGHT OF BOTTOM DEPOSITS DEMONSTRATED BY THE MINIMUM DILUTION METHOD

Station No.	Location	of station	Water depth	Incubate	ed at ca 30° C	Incubated at ca 2.5° C	
	Latitude	Longitude	(meters)	1 atm	1000 atm	1 atm	1000 atm
413	10° 20′ N	126° 36′ E	10,387	102	10°	104	10°
418	10° 13' N	126° 43′ E	10,462	10°	10 ^a	10°	10°
419	10° 19' N	126° 39′ E	10,417	10°	103	10°	10s
420	10° 24' N	126° 40' E	10,418	10^{a}	108	104	105
421	10° 29' N	126° 05' E	1,023	104	0	10s	0
422	10° 49' N	126° 01' E	2,010	104	0	10°	0
424	10° 28' N	126° 39' E	10,395	10°	104	104	10°

noteworthy that from ten to a hundred times more bacteria from the bottom of the Philippine Trench developed at 1000 atmospheres than at atmospheric pressure. Such observations establish the occurrence of barophilic bacteria at the greatest known oceanic depths, but much more work will be required to explain the temperature-pressure relationships of the organisms.

The time required (4 to 10 hours) to haul the samples from the deep-sea floor to the surface may account for finding in the mud no abnormally elongated bacterial cells such as those observed by ZoBell and Oppenheimer (6) in cultures incubated at 600 atmosphere. Predominant were rod-shaped bacteria ranging in length from 2 to 4 \mu. Many were capsulated. Endospores were found in most mud samples. Pairs of rods were common, and some occurred in short chains. Species of Pseudomonas, Flavobacterium, Vibrio, Spirillum, Bacterium, Micrococcus, Bacillus, and Clostridium were identified, and probably other genera were present. The identification of species poses special problems because of the unique pressure and temperature requirements of the deep-sea bacteria.

It may be more remarkable that many bacteria from abyssal depths survived at 1 atmosphere and 30° C than that most deep-sea bacteria seemed to prefer the low temperature and high pressure characteristic of what appears to be their natural habitat. Perfected sampling techniques will be required to determine to what extent deep-sea bacteria may be injured by the sudden changes in pressure and temperature incidental to their transfer from the sea floor to the surface. Finding some survivors fails to prove that many others may not have succumbed to the sudden change of climate. None of the animals recovered from the bottom of the Philippine Trench reached the surface alive. As reported by Bruun (7), the bottom fauna included actinians, amphipods, bivalves, echiurid worms, holothurians, and tanaids. The author concurs with Bruun in believing that deep-sea bacteria as well as animals are affected more by the change in temperature than by the change in pressure, although the two effects are closely related. As indicated by the observations of ZoBell and Johnson (8), who applied the term "barophilic" to bacteria having a preference for high hydrostatic pressure, the temperature tolerance of bacteria is affected by the pressure.

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Barophilic bacteria in abundance have also been demonstrated in several other abysses at depths ranging from 7200 to 10,080 meters, including the Soenda Deep in the Indian Ocean, the Weber Deep in the Banda Sea (9), and the Kermadec Deep in the south Pacific Ocean (10). Besides functioning as geochemical agents the deep-sea bacteria are believed to serve as an important source of food for bottom-dwelling animals, whose only other source of nutrient is the sparse supply of organic substances reaching them from the photosynthetic zone. The bacteria, which are known to nourish many animal species, can obtain their energy for growth from waste or dissolved organic matter in the circulating sea water or, in the case of certain autotrophic bacteria, from the oxidation of ammonium, methane, hydrogen, and possibly other inorganic substances.

Besides establishing the existence of bacterial life on the sea floor at depths exceeding 10,000 meters, the greatest depth being 10,462 meters, the project has provided barophilic cultures for further investigations of pressure as a physiological factor.

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George William Scarth: 1880-1951

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N SEPTEMBER 6, 1951, plant physiology lost one of her ablest and most creative devotees in the death of George William Scarth, of McGill University. Even in retirement he continued professionally active, and the issue of Plant Physiology that celebrated his seventieth birthday also contained one of his last two published papers. Although his publications were not numerous, they were models of logic, clarity, and conciseness, and true contributions to science. His early papers on "The Toxic Action of Distilled Water and the Antagonism by Cations," "The Elasticity of Gelatin in Relation to pH and Swelling," "The Penetration of Cations into Living Protoplasm," "Structural Organization of Protoplasm in the Light of Micrurgy,' etc., all showed his keen interest in the physiology of the cell; and their value is evident from the frequent citations to them in the articles and texts of other workers. His distinguished rhetorical style was attested to by one European colleague who told Scarth that one thing he always enjoyed about his papers was the fact that he always learned new words from them.

Scarth's unique contribution to science was his determined and enlightened search for mechanisms, as shown by his papers on "The Mechanism of Accumulation of Dyes by Living Cells," "Mechanism of the Action of Light and other Factors on Stomatal Movement," and "The Frost Hardening Mechanism of Plant Cells." His solutions have usually made the problems involved appear deceptively simple. As one physiologist put it on hearing his theory of frost resistance, "It is like the story of Columbus and the egg." The desire of other scientists to learn his viewpoint was shown by the frequent requests for his participation in symposia on such diverse topics as permeability, protoplasm, frost resistance, and stomatal movement.

Scarth's originality and creative spirit extended to his teaching, as well as to his research. His course in General Physiology, given in conjunction with the late F. E. Lloyd, was a striking departure from the usual run of plant physiology courses. The text resulting from this course (Elementary Course in General Physiology) was a good example of his ability to organize a variety of material into a clear, concise, and uniform whole. His conciseness was sometimes troublesome to students accustomed to having everything repeated several times. The more discerning stu-

dents have often stated that every time they read his text they discover something new. His point of view was always broad, and, like so many of the older school of scientists, he always maintained an appreciation of the plant as a whole, although he was pri-

marily a cell physiologist.

His theory of the mechanism of stomatal action, though not universally accepted, stands to this day as the explanation in closest accord with the known facts. His theory of frost resistance is also the best we have. Although onslaughts were made on his "mechanisms," he always succeeded in digesting the criticisms, accepting and extending the valid arguments against his concepts, and decisively disproving the fallacious criticisms. His last two papers, appearing in the April and July issues of Plant Physiology for 1951, in collaboration with his former student Michael Shaw, are excellent examples of this. His constant search for new methods of approach was shown by his quick appreciation of the value of the infrared absorption method for determining the CO2 and H₂O content of the air and his further development of this instrument as a means of measuring continuously transpiration, photosynthesis, and respira-

To his students, Scarth was always a source of inspiration and new ideas. He had the faculty of going straight to the core of a problem, ignoring the unessential and superficial factors. To those who knew him well, his quiet manner failed to hide a keenness and an enthusiasm for his research that stemmed from an inner excitement and an anticipation of the thrill of discovering a new fact or idea. For his greatest pleasure was the discovery and propagation of truth. Yet he always maintained a sense of humor that led to his now famous rhyme beginning:

It was four fundamentalists to learning much inclined

Who went to see the Protoplast (though all of them were blind),

and to many other humorous limericks that are not so widely known.

Great as his contributions were to the field of science, an accomplishment of equal value was his ability to kindle the fire of research in others; for it is to him that many of today's plant physiologists both in Canada and in the United States owe their interest in research. The contributions of these men and their students are in no small measure due to Scarth, and in them his spirit lives on.

News and Notes

Scientists in the News

DeForest C. Alderman, of St. Paul, has been appointed associate horticulturist at West Virginia University's experimental farm at Kearneysville. Dr. Alderman has done extension work in horticulture for Michigan State College and managed a peach cooperative for the Louisiana Fruit Growers Association.

New honorary members of the Institution of Electrical Engineers are Edward Appleton, elected for his research on the ionosphere, and Arthur Fleming, whose work in electrical engineering education has won him recognition. The Council of the Institution has awarded the Faraday Medal to E. O. Lawrence for his research in nuclear physics.

Herman G. Baity, head of the Department of Sanitary Engineering in the University of North Carolina, has accepted appointment as director of the newly established Division of Environmental Sanitation of the World Health Organization. The appointment is for one year, with the privilege of requesting an additional year, subject to the approval of the university trustees. Dr. Baity and his family will leave Chapel Hill early in June for Geneva.

The 1952 Jacob F. Schoellkopf Medal of the American Chemical Society's Western New York Section has been awarded to Henry N. Baumann, Jr., of Niagara Falls, N. Y., a physical chemist and ceramic engineer who has been associated with the Carborundum Company for the past 25 years. Mr. Baumann was cited for his pioneering research on the high-temperature behavior of silicon and aluminum compounds and for his development and use of a high-temperature microscope. He will be the 22nd recipient of the medal, which was founded in 1930 in in honor of Jacob F. Schoellkopf, Sr., pioneer in the establishment of the chemical industry in the Niagara area.

Welcome W. Bender has been appointed chief electronics engineer at the Glenn L. Martin Company, succeeding John M. Pearce, resigned. The new chief of electronics engineering activities joined the Martin Company in 1939. In 1945 he was appointed technical director, Pilotless Aircraft Section, and in 1948 was placed in charge of electromechanical design for missiles. His responsibilities were expanded in 1950 to embrace development of electromechanical systems for all Martin aircraft and missiles.

William H. Clark, epidemiologist of the Communicable Disease Center, has been dispatched from Atlanta to Khartoum, Anglo-Egyptian Sudan, to assist local health authorities in studying and controlling an epidemic of meningitis. For this mission Dr. Clark is being lent by the U. S. Public Health Service to the World Health Organization, at the request of

WHO's Regional Office in Alexandria. Dr. Clark, who was assigned to the Communicable Disease Center in July 1951, was formerly attached to the viral and rickettsial diseases laboratory of the California State Health Department.

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Edward L. Cochrane, head of the Department of Naval Architecture and Marine Engineering at the Massachusetts Institute of Technology since 1947, has been appointed dean of the School of Engineering. Admiral Cochrane succeeds Thomas K. Sherwood, dean since 1946, who has asked to be relieved of administrative duties to devote full time to teaching and research in chemical engineering, in which he has been a member of the faculty since 1930. Admiral Cochrane is at present on leave of absence to serve as head of the Federal Maritime Board in Washington. He is expected to take over the duties of dean of engineering this summer.

B. M. Currie, professor of physics at the University of Saskatchewan and a member of the Associate Committees on Geodesy and on Radio Sciences, has been appointed head of the Department of Physics, University of Saskatchewan.

Among those elected to emeritus life membership in the AAAS at the March 22 meeting of the Executive Committee is John Dearness, of London, Ontario, who will eelebrate his 100th birthday on May 13. Others named to emeritus life membership are Thomas B. Simons, William P. Boynton, Caroline E. Stachpole, and Arthur Lyman Dean.

René J. Dubos has received the 1952 Research Award of the American Pharmaceutical Manufacturers' Association for scientific contributions to the "welfare of mankind." The citation hailed Dr. Dubos as "perhaps the greatest authority on the bacteriology, immunology and biochemistry of the bacillus of tuberculosis." The French-born scientist's research work in this country over the past quarter-century resulted in the discovery of two antibacterial substances, tyrothricin and gramicidin. A member of the Rockefeller Institute for Medical Research, Dr. Dubos came to the U.S. in 1924, and in 1927 he joined the Institute. From 1942 to 1944 he was George Fabyan professor of comparative pathology and professor of tropical medicine at the Harvard Medical School, then resumed his Rockefeller post. Dr. Dubos was president of the Harvey Society in 1951 and is currently president of the Society of American Bacteriologists.

S. L. Frost has announced his resignation as executive director of the American Forestry Association. A committee selected by Don P. Johnston, association president, will name a successor at a later date.

R. Buckminster Fuller, of New York, founder and

chief engineer of the Dymaxion Corp., has been appointed a visiting critic in architectural design at Cornell University. Under the visiting critic program, Cornell's fourth-year architecture students are given opportunity to work under practicing specialists from various fields. The critic assigns a short-term project and works directly with the students in the drafting room.

J. Goubeau, of Göttingen, has accepted the chair of inorganic chemistry at the Technical University of Stuttgart.

Henry T. Heald, chancellor of New York University and former president of Illinois Institute of Technology, has been named 1952 winner of the annual Washington Award by a joint committee of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society of Mining and Metallurgical Engineers, and the Western Society of Engineers. The Washington Award was established in 1919 to honor "accomplishments which preminently promote the happiness, comfort and wellbeing of humanity."

G. Jander, of Greifswald, East Germany, has accepted the chair of inorganic chemistry at the Technical University of Berlin, British Zone.

Ruth Kahl, Public Health Service nurse officer, has been assigned to the Department of State as director of nursing for its domestic and foreign health services. In her new post Miss Kahl will work with V. T. DeVault, director of the State Department medical staff. She will direct nursing services of the department's 21 health units, 6 in Washington, D. C., and 15 abroad. Miss Kahl will take the position left vacant by the death of Emijean Snedegar, a PHS nurse officer who was killed in a plane crash near Tehran while on a field trip last December.

Charles F. Kettering, past president of the AAAS, was one of seven recipients of Horatio Alger awards for 1952. Others whose rise to eminence from humble beginnings was similarly recognized are Ralph Bunche, Milton Eisenhower, James J. Kerrigan, Thomas E. Millsop, Norman V. Peale, and W. A. Roberts.

Jorge León, of the Department of Plant Industry, Inter-American Institute of Agricultural Sciences, has received a Guggenheim fellowship and is studying cytology and taxonomy at Washington University. J. Harvey McLaughlin, plant pathologist of the Inter-American Cacao Center, has resigned, to return to the U. S.

Leo Marion has been appointed director, jointly with E. W. R. Steacie, of the Division of Pure Chemistry at the National Research Laboratories of Canada. Dr. Marion was formerly assistant director and will continue his work as head of the organic chemistry section. Ira E. Puddington has been appointed director of the Division of Applied Chemistry, to succeed the late Adricn Cambron. Dr. Pudd-

ington will continue his work as head of the colloids section.

Charles D. Marple has been appointed medical director of the American Heart Association. He has been assistant clinical professor of medicine at the University of California School of Medicine, San Francisco, since 1950.

The Holweck Medal and Prize have been awarded by the Council of the Physical Society (London) to Louis Neel, of the University of Grenoble, for his work in magnetism.

Donald L. Petitjean, a student at the University of Wisconsin, has been awarded the \$2500 Merck Graduate Fellowship in Analytical Chemistry. The grant, sponsored by Merck & Co., Inc., makes possible a year's study at an institution of higher learning in the U. S. or Canada. Mr. Petitjean will continue research at the University of Wisconsin under the direction of W. J. Blaedel. The Merck fellowship, established in 1948, is given to the applicant whom the American Chemical Society considers likely to "contribute most to the advancement of the theory and practice of analytical chemistry during the period of the fellowship and the course of his future career." During the tenure of his fellowship, Mr. Petitjean will study methods of chemical analysis using high-frequency electrical instruments.

Arthur C. Proetz, professor of clinical otolaryngology at the Washington University School of Medicine, is the second American invited to give the annual Semon Lecture in London. A memorial to Felix Semon, one of the distinguished laryngologists of the Victorian era, the lectureship is the highest distinction offered by British laryngology. Dr. Proetz will speak on some phase of nasal physiology at the University of London in November.

Piya Rangsit, Siamese scientist and prince, has been visiting the Communicable Disease Center, Public Health Service, and the School of Veterinary Medicine, University of Georgia. His four-month visit to the United States is sponsored by the Department of State. The Department of Agriculture and the Public Health Service are planning his travel and visits to medical centers.

Henry Sterling, of the University of Wisconsin Geography Department, recently made his second trip to the mountainous region of Venezuela to draw up plans for extensive research to improve the area. The mission was undertaken at the request of the Venezuelan Rural Welfare Council and the American International Association, cooperating on a project to help solve agricultural, education, and health problems in the country.

On June 1, John Fuller Taylor will become professor of biochemistry and head of the department at the University of Louisville School of Medicine. He will succeed A. W. Homberger, who is retiring. Dr. Taylor has been assistant professor of biological

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chemistry at Washington University School of Medi-

George Urdang, professor of pharmacy at the University of Wisconsin, will retire from the university faculty this year, at the age of 70. A specialist in the history of pharmacy, Dr. Urdang came to this country in 1939, and shortly thereafter became director of the newly founded American Institute of the History of Pharmacy.

Education

The Air Force Cambridge Research Center seminars of the Geophysical Research Directorate will have J. Holmboe, of the University of California, Los Angeles, as a speaker on May 16. He will discuss "The Stability of Parallel Flow." J. Kuettner, of the Geophysics Research Division, will end the current series on June 6 with a "Discussion of Traveling Waves and Clear Air Turbulence in the Jet Stream." The seminars, which are held in South Boston, will be resumed in September. For information, write to Ephraim Radner, 230 Albany St., Cambridge 39, Mass.

Duke University Marine Laboratory, in cooperation with the Fish and Wildlife Service, will offer a course in Biohydraulics June 16-July 19. Milo Bell, technical coordinator for the Washington Department of Fisheries and consultant to the Salmon Commission, will teach the course. Further information may be obtained from the director of the Summer

In cooperation with the National Science Teachers Association the University of Michigan will hold a workshop in the Teaching of Science in the Elementary and Secondary Schools, June 23-July 3, The NSTA summer conference on science teaching will be held on the campus June 26-28.

Ohio State University College of Arts and Sciences will make changes next fall in its bachelor of science program. The new plan will permit students to change their fields of specialization with the least possible waste of time and credits, and eliminate certain restrictions on sequence of courses. One requirement will be 25 hours of studies in the social sciences, humanities, and philosophy. Not more than 75 hours may be taken in any one department, and 10 hours of work must be taken in mathematics.

At the University of Pittsburgh School of Pharmacy, Edward P. Claus will be in charge of a course in Allergenie Plants, June 16-July 25. The course is designed for advanced students of botany or pharmacognosy and for physicians interested in allergy. It will include field observations of hay fever trees, grasses, and weeds, laboratory identification of windborne pollen grains and spores, and cultural studies of allergy-producing molds.

Temple University School of Medicine is inaugur-

ating a program of graduate study in the basic medical sciences leading to the M.S. and Ph.D. in anatomy, microbiology, pharmacology, physiological chemistry, and physiology. Only a limited number of students can be accommodated, and preference will be given to applicants for teaching fellowships carrying an annual stipend of \$1800.

Because of continued financial loss in the operation of the FM radio station WDET, the UAW-CIO has made a gift of the land and all equipment to Wayne University, which will use the station for the training of students and for educational and cultural programs.

Grants and Fellowships

The Duke University Marine Laboratory is offering 10 graduate scholarships, covering tuition, board, and room, for summer work in one of the following courses: Marine Ecology, June 12-July 19; Biohydraulics, June 16-July 19; Marine Invertebrate Zoology, July 22-Aug. 29; Special Problems in Botany, July 22-Aug. 29. Applications and transcripts should be sent to C. G. Bookhout, Zoology Department, Duke University.

Seventy-one Public Health Service fellowships have been awarded to researchers in institutions in 17 states and Canada and to 7 U.S. residents who will study in Denmark, England, France, and Sweden. Universities in California received 16 grants; Illinois was next with six grants. Total funds allotted amounted to \$184,641.

In its first quarterly report for 1952, the Rockefeller Foundation listed appropriations totaling slightly more than \$2,000,000. Among the projects receiving support are the Near East studies at Princeton; the program in the physical chemistry of proteins at Yale; the Scripps Foundation for Research in Population Problems at Miami University, Oxford, Ohio; economic behavior studies by the Survey Research Center, University of Michigan; the state health program of the University of North Carolina; and research in enzyme chemistry at the Massachusetts General Hospital. Research abroad received its share of support, with \$105,000 to the Tavistock Institute of Human Relations in London; \$200,000 to Sweden's Carolinian Institute for a surgical laboratory; and \$60,000 for Uruguay's Research Institute of Biological Sciences. Typical of the foundation's interest in international exchange of professional experience is the support given to the Gordon Research Conferences of the AAAS, to defray the expenses of foreign scientists who participate in certain of the conferences.

Grants and fellowships in excess of \$200,000 have been approved for 1951-52 by the Committee on Fellowships and Grants of the Squibb Institute for Medical Research. Grants ranging in amounts from \$100 to \$12,000 have been awarded to medical researchers and graduate students of institutions in 16 states well :

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states, the District of Columbia, and Puerto Rico, as well as six foreign countries.

In the Laboratories

Bjorksten Research Laboratories have formed a Radiochemicals Division, to be housed in especially constructed laboratory facilities at Madison, Wis. Howard L. Gottlieb, who has been studying at Oak Ridge, will be in charge of the new division.

Cornell Aeronautical Laboratory has recently appointed Karl Swartzel, former head of the Physics Department, to the director's office as staff scientist. Seville Chapman will succeed him as head of the Physics Department, Mark Foster will become head of the Development Division, and Robert Shatz will become head of Special Projects. Edward Dye will head the new Industrial Division. Richard H. Lloyd, of Experiment Incorporated, Richmond, has joined the Aero-Mechanics Department as a research engineer in composite design.

Houston Oxygen Company has opened its new million-dollar plant for the production of pure liquid oxygen and nitrogen, and pure oxygen, nitrogen, and argon gases. At the same time the first pipeline to supply multiple industrial customers with dry oxygen gas was put into operation.

Los Alamos Scientific Laboratory has added the following scientists to its staff: Theodore M. Benziger to the GMX Division, and Robert D. Fowler, former professor of chemistry at Johns Hopkins, to the CMR Division.

Harold J. Koepsell has joined the staff of Parke, Davis Research Laboratories as head of a group of researchers on the microbiological and biochemical aspects of antibiotic fermentation. He was formerly with the Fermentation Division of the USDA Northern Regional Research Laboratory. Frances R. Roegner and DeVere M. Gallup have joined the same division.

Sharp & Dohme has appointed two new research associates: Alfred A. Tytell, of the College of Medicine, University of Cincinnati, to work in antibiotics, and Charles J. Wiley, of Foote Mineral Co., to work in chemical development.

At Southwest Research Institute, Robert J. Anderson, consulting metallurgist, has been appointed head of the new Department of Metallurgy, and Judson Swearingen has been named director of petroleum technology. Dr. Swearingen has been chairman of chemical engineering at Southwest.

Union Carbide and Carbon Corporation has named Morse G. Dial president to succeed Fred H. Haggerson who will continue as chairman of the board. Walter E. Remmers, president of the Electro Metalurgical Company and U. S. Vanadium Company, both divisions of Union Carbide, has been made vice president of the Alloys Division.

Meetings and Elections

The meetings of AAAS Section I (Psychology) will be held Dec. 29-30, during the annual meeting in St. Louis. Abstracts should be submitted not later than Sept. 15 to Delos D. Wickens, section secretary, 404 University Hall, Ohio State University, Columbus 10, and should not exceed 600 words excluding title. They should include the author's job affiliation and his name as he would like it to appear on the program. Participants need not be members of the AAAS.

The American College of Cardiology will hold its first annual convention in the Hotel Statler, New York, June 6-7. Four scientific sessions will be devoted to a symposium on "Treatment of the Cardiae." For full information, write Philip Reichert, 480 Park Ave., New York 22.

The Eastern Psychological Association has elected Neal E. Miller president; G. G. Lane secretary (3 years); and Stuart W. Cook, Fred S. Keller, and Carl Pfaffmann to the Board of Directors.

Flame Photometry in Clinical Chemistry will be the subject of a symposium sponsored by the American Association of Clinical Chemists at Walter Reed Army Hospital at 8:00 p.m., May 13. John Reinhold Robert Bowman, and Robert Berliner will be the principal speakers. Following the program the association will undertake the formal organization of a Washington Section. All interested persons in the Washington area are invited to attend.

An International Symposium on Anthropology will be held by the Wenner-Gren Foundation for Anthropological Research in New York June 9-20. Eighty-five scholars, including 33 from foreign countries, have been invited. A. L. Kroeber will be president of the symposium. Theme of the meeting will be "A World Survey of the Status of Anthropology."

The third National Medicinal Chemistry Symposium will be held June 12–14 at the University of Virginia. Subjects to be discussed include the chemotherapy of virus infections, the role of the pituitary and the adrenal cortex in homeostasis, drug metabolism, the circulatory system, and enzyme chemistry in relation to the action of medicinal agents. Scientists from various universities and laboratories, including Oxford University and St. Mary's Hospital Medical School, London, will participate. Alfred Burger, of the Virginia Department of Chemistry, is general symposium chairman.

A Symposium on Colloidal Electrolytes, in honor of Herman V. Tartar, member of the Department of Chemistry and Chemical Engineering, University of Washington, for 35 years, will be held May 19-20. Four informal discussion sessions, under the leadership of M. L. Corrin, R. M. Fuoss, C. A. Kraus, and P. J. Debye will be held. Further information may be obtained from E. C. Lingafelter, University of Washington, Seattle.

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Miscellaneous

The Danish research ship Galathea, which operated during January in New Zealand waters, visited the Kermadecs in February. On her way to the Kermadecs she surveyed the trench off the Auckland coast in the expectation of finding deeper water than the present record of 34,000 feet. During this phase of the work the following scientists were invited to join the expedition: A. W. B. Powell, of Auckland Institute and Museum, chairman of the Pacific Science Association Subcommittee on Biological Oceanography; R. K. Dell, of Dominion Museum, Wellington; M. Cassie, of the New Zealand Marine Department; and Richard Morita, of the University of California. Mr. Morita, representing the Office of Naval Research, Washington, is working primarily on the isolation of deep-sea microorganisms, continuing the work of Claude E. ZoBell (Science, 114, 429 [1951]; 115, 507 [1952]), who left the ship at New Guinea last October. Another study planned for the expedition is of the inner ear organs of fish, by Thure Vilstrup, of Copenhagen.

At its annual meeting in Washington, D. C., the National Academy of Sciences made the following gold medal awards: the Alexander Agassiz Medal to Harry A. Marmer, U. S. Coast and Geodetic Survey; the Daniel Giraud Elliot Medal to Henry B. Bigelow, Harvard, and the James Craig Watson Medal (established in 1874) to Herbert R. Morgan, Yale. The Henry Draper Medal, awarded to the late Bernard Lyot, Meudon Observatory, Paris, prior to his death, was accepted on behalf of the Lyot family by the French Ambassador.

A. R. Todd, professor of organic chemistry at Cambridge University, has been appointed to the chairmanship of the British Advisory Council on Scientific Policy. The appointment took effect at the end of March upon the retirement of Henry Tizard. F. Zuckerman will continue as deputy chairman to the council. Professor Todd retains his position at Cambridge.

Recent Deaths

Wingate M. Anderson (57), former president, Standard Oil Company of Brazil, Sharon, Conn., Mar. 22; George B. Bader (56), pediatrician, New York, Apr. 18; Julien Besançon (90), specialist in longevity, Paris, Apr. 16; Louis H. Bridwell (-), zoologist, Forestburg, Tex., Oct. 29, 1951; Barney Brooks (67), surgeon, Nashville, Tenn., Mar. 30; A. Cambron (58) chemist, Ottawa, Ont., Feb. 22; William H. Campbell (100), educator, Chicago, Apr. 15; R. Franklin Carter (57), surgeon and diagnostician, New York, Apr. 19; Lewis W. Chubb (69), electrical engineer, Pittsburgh, Apr. 2; W!!liam R. Cole (72), food technologist, North Ardover, Mass., Apr. 11; Harold T. Coss (52), ceramic engineer, New York, Mar. 12; Harry R. Darling (73), formerly of Eastman Kodak Company, Wolcott, N. Y., Apr. 8; Arthur W. Dean (81), highway engineer, Winchester, Mass., Mar. 20; Louis Dede (67), former editor Physikalischen Berichte, Germany, Aug. 23, 1951; Richard E. Dodge (84), geographer,

Willimantie, Conn., Apr. 2; André Dreyfus (55), geneticist, São Paulo, Feb. 16.

Charles R. Forbes (74), engineer, Washington, D. C., Apr. 10; Malcolm C. Foster (58), mathematician, Middletown, Conn., Apr. 9; Leonard E. Hill (85), physiologist, Corton, Eng., Mar. 30; William E. Howes (57), of Brooklyn, N. Y., radiologist, Honolulu, Apr. 5; George R. Irving (61), pediatrician, New York, Apr. 14; Lambert L. Jackson (81), educator, Tueson, Ariz., Mar. 28; Felix Jacobi (69), gynecologist, New York, Apr. 1; Austin F. James (81), dentist, Beverly Hills, Calif., Apr. 13; Elizabeth Jarrett (87), physician, New York, Mar. 26; Lewis J. Johnson (85), civil engineer, Cambridge, Mass., Apr. 15.

Robert Kahn (67), ophthalmologist, New York, Mar. 26; Maxwell H. Kaiden (62), ear, nose, and throat specialist, New York, Apr. 9; Raymond A. Kelser (60), veterinarian and bacteriologist, Philadelphia, Apr. 16; Harold Kirby (52), zoologist, Berkeley, Calif., Feb. 21; Edwin R. Knapp (-), engineer, Florham Park, N. J., Mar. 25; Rudolf W. Ladenburg (69), physicist, Princeton, N. J., Apr. 3; Marie Litzinger (52), mathematician, Bedford, Pa., Apr. 7; Ugo Lombroso (-), physiologist, Genoa, Italy, Apr. 11; Bernard Lyot (55), of Paris, astronomer, Cairo, Egypt, Apr. 1; George M. Mackenzie (66), of Cooperstown, N. Y., pathologist, Charlottesville, Va., Mar. 25; Robert M. Marcussen (34), internist, Menlo Park, Calif., Apr. 13; Thomas W. Marshall (80), civil engineer, Washington, D. C., Mar. 28; Henry D. Minich (62), plastics executive and inventor, Tarrytown, N. Y., Mar. 22; Charles E. Mongan (92), physician, Somerville, Mass., Apr. 13; Roger L. Morrison (68), highway engineer, Ann Arbor, Mich., Mar. 23; Chester D. Mott (64), research engineer, Evanston, Ill., Apr. 1.

Earl R. Norris (56), biochemist, Seattle, Wash., Mar. 30; Louis G. Pacent (58), radio engineer, New York, Apr. 7; Edward F. Parks (85), inventor, Providence, R. I., Apr. 5; J. Randolph Perdue (43), obstetrician, Miami Beach, Fla., Mar. 27; James L. Peters (62), zoologist and ornithologist, Cambridge, Mass., Apr. 19; David Polowe (-), surgeon, Paterson, N. J., Apr. 3; Carl E. Pretzell (76), chemist, Bremerhaven, Germany, Apr. 2; Theodore Reichbaum (55), cardiologist, Easton, Pa., Apr. 16; Ernest W. Riggs (70), educator, Dallas, Tex., Mar. 25; Fred J. Sales (51), educator, Redlands, Calif., Mar. 24; Ernest R. Smith (60), geologist, Ithaca, N. Y., Mar. 20; Max Steineke (54), geologist, Los Altos, Calif., Apr. 16; John J. Sweeney (62), obstetrician, Philadelphia, Apr. 18; Douglas Symmers (72), pathologist, New York, Apr. 19; Edward Taylor (76), engineering mathematician, Claremont, Calif., Apr. 7; C. Forrest Tefft (62), ceramicist, Columbus, Ohio, Apr. 12; Francis M. Turner (61), publisher and chemist, Manhasset, N. Y., Apr. 3; James G. Vail (65), chemist, Delhi, India, Dec. 11, 1951; Fanny von Hann-Kende (60), psychoanalyst and psychiatrist, New York, Apr. 14; Julius B. Wantz (78), engineer and inventor, River Forest, Ill., Apr. 6; George G. Weinert (52), physicist and mechanical engineer, Lakewood, N. J., Mar. 22.

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Technical Papers

Birefringent Stepgauge

Katharine B. Blodgett

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General Electric Research Laboratory, Schenectady, New York

The barium stearate stepgauge¹ has demonstrated the usefulness of a gauge that measures the thickness of films a few microinches thick by means of the interference colors that they reflect. It consists of a plate of special glass on which monolayers of barium stearate have been built up in a series of steps having thicknesses 2, 3, 4, . . . 16 n.icroinches.

A new type of stepgauge has been made which makes use of the principle that a birefringent material, placed between two properly oriented polarizing films, transmits light which, in general, exhibits inter-

ference colors.

Many plastics that are commercially available in thin sheet form are birefringent. Ordinary cellophane is a familiar example. A small square piece cut from a new sheet of Dupont waterproof cellophane with its edges parallel to the edges of the sheet transmitted light of a blue color when placed between two parallel polarizing films, and yellow between two erossed polarizing films. In each case the piece was oriented with its four edges making an angle of 45° with the direction of the polarizers. This phenomenon has been commonly employed for demonstrating some of the properties of birefringent materials.

The birefringent stepgauge consists of a set of small pieces of a birefringent plastic, cut and stacked together so as to form a flight of steps. Each step differs from the next by a constant thickness, which is usually the thickness of one layer of plastic. A series of 10 steps having a convenient size can be made by cutting a strip of plastic $1\frac{1}{2}$ " wide from a sheet, and then cutting it into 10 pieces having the successive lengths 3", $2\frac{3}{4}$ ". . . . $\frac{3}{4}$ ". These are stacked together and

bound with Scotch tape around the edge.

When the birefringent stepgauge is sandwiched between polarizing films with the direction of the stepgauge making an angle of 45° with the direction of the polarizers, bright colors are seen by transmitted light. The colors vary from step to step. They are interference colors which occur because the light is split into two rays that travel through the plastic with different velocities and therefore emerge from the plastic with a phase difference. The light that passes through the second, or "analyzing," polarizer is the resultant of two rays having a phase difference. The light, therefore, exhibits interference colors that are identical with those seen in the light reflected by very thin films of transparent substances.

Interference colors ordinarily belong to one or the other of two different series. The color exhibited by

¹Barium Stearate Stepgauge, General Electric Company Instruction Manual. one series for any given path difference of the two interfering rays is complementary to that of the other series for the same path difference. The new stepgauge exhibits the two series. The colors seen with the polaroids parallel are the same as those reflected by a thin film when $n_0 < n_1 < n_2$, where n_1 is the refractive index of the film, and n_0 and n_2 of the media on either side of the film. The colors seen with crossed polaroids are the same as those exhibited by a thin film for the cases $n_0 < n_1 > n_2$ and $n_0 > n_1 < n_2$.

The interference minima for monochromatic light

occur as follows:

a) Parallel polarizers. Minima occur at an "effective path difference," Al, given by

$$\Delta l = \lambda/2$$
, $3\lambda/2$, . . . etc.,

where "effective" refers to the path difference in air that corresponds to the phase difference of the two rays.

b) Crossed polarizers. Minima occur at

 $\Delta l = 0, \lambda, 2\lambda, \dots$ etc.

The new stepgauge can be used to measure accurately the thickness of films a few microinches thick, in the same way that measurements are made with the barium stearate stepgauge, by matching the color of the film that is to be measured to that of one of the steps on the gauge. The birefringent gauge must first be calibrated. This can be done by viewing a source of monochromatic light, such as a sodium lamp, through the stepgauge and polarizers.

As an example, a stepgauge was made of 12 steps of Kodapak² 0.015" thick. The first minimum for perpendicular sodium light seen with crossed polarizers was found to occur at step 9, and the first minimum with parallel polarizers at step 4.5 (interpolated between 4 and 5). Therefore, the calibration for the

gauge is

 $\Delta l_g = \lambda/9$ per step for sodium light,

where the subscript g refers to the gauge.

In the case of perpendicular light reflected by a thin film, the lag between the two rays due to distance retardation is given by

$$\Delta l_f = 2nt$$
,

where n and t are the refractive index and thickness, respectively, of the thin film. Therefore, one step of the gauge produces the same lag as a thickness $\lambda/18n$, which is 218 A for a material for which n=1.5.

The steps of the barium stearate stepgauge are commonly made with a steprise 244 A, which is nearly 1 microinch. When the colors of the birefringent stepgauge which has just been described are compared with those of a barium stearate stepgauge, they are found to differ by the small amount predicted by the calibration.

The amount of lag per step is determined by the ² Manufactured by Eastman Kodak Company, Rochester, N. Y. product $Nt\Delta n$, where N is the number of layers in a step, t the thickness per layer, and Δn the difference in refractive index for the two polarized rays. Since many different plastics having a wide variety of birefringence and thickness are commercially available, a variety of stepgauges can be made having different "steepness" for the flight of steps. Ordinary cellophane was found to have more birefringence than was desirable for a stepgauge. A flight of steps made of cellophane had too great optical steepness to be generally useful as a measuring instrument.

The steps of a birefringent stepgauge are commonly cut out of a sheet of plastic with all the steps in the same direction of the sheet. In this case the thicknesses add. If a step is cut out of the sheet in a direction at right angles to the direction of the rest of the steps, its thickness will subtract from that

of the series. The birefringent stepgauge is not yet commercially

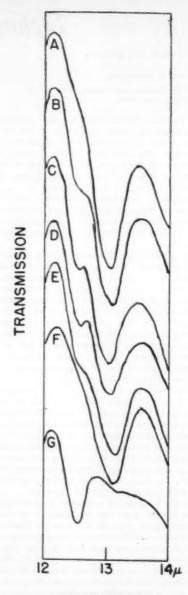
Manuscript received February 20, 1952.

An Observation on the Infrared Absorption Spectrum of Dextran

Stanley C. Burket and Eugene H. Melvin Northern Regional Research Laboratory,1 Peoria, Illinois

In an extensive study of the physical characterization of dextran, we have examined the infrared absorption spectra of dried films of a wide variety of undegraded and degraded dextrans produced by different organisms under different conditions. The instrument used was a Perkin-Elmer Model 21 infrared spectrophotometer.2 Throughout most of the spectral region 3 µ-15 µ, these spectra resemble each other quite closely, but some significant differences have been found. The largest variations occur in the spectral neighborhood of 12.6 µ, and a few examples of particular interest are shown in Fig. 1. It will be noted that, of the commercial dextrans, the nondomestic show marked differences from the domestic in the amount of absorption at 12.6 µ. Samples of dextran produced by Leuconostoc mesenteroides NRRL B-512 do not show appreciable absorption at 12.6 µ; NRRL B-512 and the organism that produces the domestic dextran stem from the same original culture. Dextrans produced by other organisms in the NRRL culture collection show varying amounts of absorption at 12.6 µ. One dextran we have studied in particular is produced by L. mesenteroides NRRL B-742. Undegraded dextran from this latter source has been fractionated by alcohol precipitation from water. Two fractions, labeled in Fig. 1 as B-742, Type I, and B-742, Type II, have been obtained. The physical

One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.
^a Mention of the instrument used does not constitute an endorsement by the U. S. Department of Agriculture.



WAVELENGTH

Fig. 1. Infrared absorption spectra of dried films of different dextrans between 12 μ and 14 μ . A, commercial, domestic; B, C, and D, commercial, nondomestic; E, unfractionated B-742; F, B-742, Type I; G, B-742, Type II.

characterization of these materials will be discussed later by others, but we can say that the molecular weights of the two fractions as determined by light scattering are approximately the same. The spectra of un

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these and other dextrans that we have studied are unchanged in the low molecular weight (about 30,-000) material isolated by alcohol precipitation after

acid hydrolysis.

One way of accounting for the spectra of the nondomestic dextrans would be to assume that they are mixtures of Types I and II in varying quantities. If we further assume (1) that the spectrum of dextran is independent of type except from 12 μ to 14 μ and (2) that the Type II dextran, the spectrum of which is shown in Fig. 1, contains a negligible amount of impurities, we can assign percentages of Type II dextran to the various dextrans whose spectra are shown in Fig. 1. The percentages so obtained follow:

A		- 2
\boldsymbol{B}	g	20
C	P-10	35
D	BARTON BA	40
E		3!

A more extensive discussion of the infrared absorption spectra of dextrans will be published elsewhere. Manuscript received November 30, 1951.

An Ultramicronutritional Bio-Assay Technique Employing Seeded Agar Tubes

Maurice E. Shils, Martin Horowitz, Anna Cheskis Gelman, and Martin Sass¹

School of Public Health, Columbia University, New York

The need for estimating nutrients present in foods and biological materials has resulted in the development of valuable microtechniques (chemical, microbiological, and chromatographic). However, there is a continuing requirement for simple and sensitive procedures for use in clinical work, especially with children, for field work in nutrition surveys, and for small-animal experimentation to avoid sacrificing the organism; the procedures should be capable of measuring nutrients in very small amounts of biological fluids and tissues. Available microchemical procedures for the routine determinations of thiamin, riboflavin, ascorbic acid, vitamin A, and carotene on a few drops of blood (1) require expensive and delicate equipment, presenting a serious problem in field work and in modestly equipped laboratories. In addition, ultramicrochemical methods are not available for many of the B vitamins. Microbiological assay techniques of either the test-tube or agar-plate type as commonly employed (2) are not sensitive enough for the purposes indicated, but they have a simplicity and range that make adaptation of their principle desirable at ultramicro levels.

We report here initial observations on a simple and rapid microbiological assay procedure, suitable for vitamins and amino acids, which employs a small-bore

¹This study has been supported by a grant from Merck & Co., Inc., Rahway, N. J.



Fig. 1. Agar tube assay for riboflavin illustrating the turbid appearance of the seeded agar medium where the organism (*L. casei*) has grown in response to the supernaturiboflavin solution. From left to right, the tubes contain 0.0 (blank), 0.025, 0.05, 0.25, and 0.5 µg riboflavin/ml, respectively; in each instance 0.035 ml of solution was added. Incubation for 18 hr at 30° C.

glass tube containing agar-basal medium seeded with the test organism. The basal medium is deficient only in the nutrient to be assayed, and the organism employed requires the nutrient for growth. The test solution is added above the agar column, and after suitable incubation the length of the column of growth is measured (Fig 1). The procedure is an adaptation of the agar-plate assay technique (3) but with many advantages in sensitivity and simplicity. Seeded agar tubes in various modifications have been used for antibiotic assay (4-7).

The graded response (length of growth column) has been found to bear a linear relation to the logarithm of the concentration of the added nutrient over most or all of the ranges tested (Fig. 2). A similar relation has been found in various agar-plate assays (3–10). Four vitamins and three organisms thus far tested have shown the graded response (Table 1), and it is believed that this response will obtain wherever an organism will grow in a low oxygen tension without gas formation upon the addition of a missing essential nutrient. Saccharomyces carlsbergensis ATCC No. 9080, for example, has not yielded satisfactory results to date in testing for the vitamin B₆ group.

A number of variables have been and are being tested for optimum results, including concentrations

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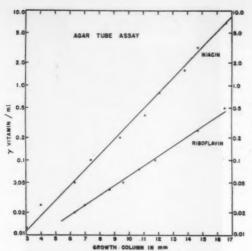


Fig. 2. Agar tube assay for riboflavin and niacin illustrating linear relation between vitamin concentration (logarithmic) and length of growth column. Each point is the average of 3 readings, 0.030 ml solution/tube, incubation for 19 hr at 37° C.

of agar, types and concentrations of basal media and of organisms, sealed vs unsealed tubes, age of bacteria, pH of added solution, methods of filling tubes, and others. The procedure currently used is as follows: The bacterial cultures are handled in the usual fashion for microbiological assay and, after inoculation, 18-hr incubation, and two saline washings, the bacterial suspension is brought to a suitable turbidity (Table 1). Basal medium of the proper strength

from slipping through.³ The tubes are filled for approximately 5 cm of their length by partial immersion in the liquified seeded agar and are then left horizontal until the agar has hardened.

The test material is added at the top of the tube with a constriction micropipette (1) of 0.015 ml or greater volume and incubated in a well-humidified chamber for 16-20 hr at the optimum temperature for the test organism. The tubes need not be sealed. The length of the growth zones is measured with an inexpensive vernier caliper allowing readings to 0.1 mm; a black background and fluorescent light assist in noting the boundary. Provided complete evaporation of the test solution does not occur during incubation, appreciable variation in the volume added does not appear to influence the length of growth column significantly. Standard nutrient solutions are run in triplicate at suitable concentrations. Sterile technique is necessary only in the handling of the cultures and basal media.

The seeded tubes may be wrapped in batches in vaporproof material and stored in the refrigerator until ready for use. We have tested agar tubes seeded with Lactobacillus casei and stored for varying periods; good readings with riboflavin have been obtained following 3-4 days' storage. Column lengths at a given vitamin concentration increase with storage time.

It has been found that the effective (readable) range of the agar tube assay is much greater than for the standard tube assay (Table 1). With pure riboflavin solutions serving as "unknowns," the accuracy of the agar tube assay approximates that of the Snell and Strong assay procedure (11).

The simplicity, speed, and extensive range of the

TABLE 1

DATA ON AGAR TUBE MICROBIOLOGICAL ASSAY

						Effective range (µg)	
Vitamin	Organism and A	TCC No.	Mediun	and strength	T*	Agar tube†	Liquid tube
Thiamin	L. fermenti	9338	D-B‡	1X	90-95	0.02 -10.0	0.01-0.04
Riboflavin	L. casei	7469	D-B;	(11) modified 1X	81-83	.02 - 1.0	.05-0.3
Niacin Pantothenic acid	L. arabinosus	8014	D-B D-X	1X 1/2 X	81-83 81-83	0.05 - 12.5 0.025 - 12.5	0.01-0.4 $0.01-0.08$

* T = optical density of suspension of culture used for seeding, using Evelyn colorimeter, 540 filter,

† Using 0.03 ml of vitamin solution. The upper limits of effective range and the linearity of response have not yet been thoroughly investigated above these levels.

‡ D-B = Difco-Bacto assay medium for the particular assay.

(Table 1) containing 0.6% agar is autoclaved and allowed to cool to 42°-45° C. Five ml of the bacterial suspension is then added per 100 ml of agar-basal medium, and the tubes are filled. The glass tubes are 8 cm long, 3.5 mm OD and 2.0 mm ID² and have the lower end partially flame-sealed to prevent the agar

² Similar results have been obtained using tubes of 0.9 mm ID; the degree to which diameter may be reduced would appear to be limited only by practical considerations of methods of introducing liquid and of measuring growth column.

agar tube assay commend it for trial in control work with potent vitamin sources and in establishing the range of vitamins in solutions of unknown strength preliminary to measurement by established chemical and microbiological procedures. Further investigation

⁵ Glass tubing, cleaned with acid and washed until rinsings are no longer acid, must be treated with a detergent such as Alconox in order to prevent changes in the agar that result in imbibition of the supernatant liquid, with drying and fragmentation of the agar surface and variable results.

will determine whether it will stand on its own merits as an independent assay procedure with biological material.

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Effect of Wind-generated Waves on Migration of the Yukon River in the Yukon Flats, Alaska1

John R. Williams

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Wind-generated waves influence the migration of the Yukon River in east-central Alaska. At Circle, 125 miles downstream from the Alaska-Canada boundary, the Yukon River enters the eastern end of the Yukon Flats, an alluvial basin 20-75 miles wide and nearly 200 miles long. The Flats comprise a lowland that includes the Yukon Valley and lower parts of tributary valleys. Tributaries entering from the north are Porcupine, Sheenjek, Christian, Chandalar, Hodzana, Hadweenzic, and Dall rivers. Those entering from the south are Birch and Beaver creeks. Seven miles below Stevens, the river leaves the Flats through a narrow canyon.

From Circle to Fort Yukon the course of the Yukon is N 45° W and it is complexly braided. From Fort Yukon to a point downstream from Beaver the river changes its course to S 75° W and flows in a wide main channel, from which bow-shaped sloughs branch and re-enter. Along the north bank the channel is complicated by numerous distributaries of the Chandalar and Porcupine rivers. Near Stevens the Yukon is confined to one broad watercourse that locally branches into as many as three or four smaller channels.

Throughout the Yukon Flats, the riverbanks consist of unconsolidated alluvial gravel, sand, and silt, with minor amounts of organic material. In many places these banks are perennially frozen. Where the north bank of the river is 20'-30' above summer river

² Publication authorized by the director, U. S. Geological Survey.

level, it is characterized by a well-developed soil profile. The vegetation is more like that found on older surfaces near the margin of the Yukon Flats than like vegetation on the south bank of the river, which is lower and lacks a well-developed soil profile. South of the river islands and bars are more numerous, and abandoned channels are filling with silt deposited during floods. These facts suggest that the alluvial features to the south are more recent than those to the north, and that the south bank has grown northward by deposition as the north bank retreated by erosion.

Russell (1), Goodrich (2), and Eakin (3) were among the first to suggest that the Yukon is migrating northward, basing their conclusion on the fact that the current is swifter along the north bank, where the stream is eroding the older, higher ground. To account for this migration in the Yukon Flats, Goodrich (4) applied Ferrel's law of terrestrial rotation, in which horizontally moving bodies are deflected to the right in the Northern Hemisphere. Deflection of a westflowing river, such as the Yukon, would force migration to the north, Goodrich (5) attributed the asymmetry of some of the smaller tributary valleys to the effects of geologic structure and regional tilting. If the tilting theory were applied to the Yukon in the Flats, uplift of the area south of the river might force the river northward.

Field evidence indicates that the course of the Yukon was shifted south of its present position by deposition of gravel fans in the lower valleys of the Christian, Chandalar, and Sheenjek rivers during a period when glaciers, with sources in the Brooks Range, moved down the valleys. Since the last major glacial advance, the Yukon appears to have migrated northward and, in a few places, is eroding the lower part of the gravel fan of the Chandalar River.

At present the strongest summer winds are from the southwest, as observed by the writer and by residents of Beaver, a small village on the north bank of the Yukon. These winds, blowing against the river current, produce choppy waves with a trough-to-crest height up to 3'. The waves attain their maximum height and erosive power along the north bank of the river, especially where the wind blows unobstructed across a wide expanse of water. The south bank, in contrast, is protected from waves generated by summer winds; and in winter the prevailing northeast winds and the strong southwest winds associated with cyclonic storms cannot form waves on the ice-covered river.

Frozen banks are thawed rapidly at water level and below, and at a slower rate by warm air above water level. They thus become prey to undercutting at a rate that depends on the degree of cementation of the alluvium by ice and on the rate of removal of the eroded sediment. Frozen silt, the most cohesive bank material, can be undercut farther than frozen gravel or sand or thawed material. The process is accelerated by wind-generated waves and results in the collapse of large blocks of silt, which temporarily defend the bank against further erosion by waves and current until they are thawed and removed. Where the banks consist of frozen sand and gravel or thawed material, they are also effectively eroded by wind-generated waves and river current.

Local residents reported erosion of a strip approximately 200' wide along the north bank of the Yukon downstream from Beaver during a summer characterized by long periods of strong southwest winds. In June 1950, after breakup of the river ice, strong upriver winds produced waves which, together with the current, caved the frozen silt banks upstream from Beaver as much as 35' in two days, whereas moving river ice had relatively little effect. In August 1949, a section of the bank was undercut by waves and current and slumped into the river. This block was circumscribed by a crack that extended 90' back from the river.

Wind-generated waves erode lake margins in much the same way, although the added effects of current and rapid fluctuations in level are lacking. The shores of some of the larger lakes in the Yukon Flats are being eroded by waves. Elongation and orientation of lakes on the arctic coastal plain of Alaska (6) and enlargement of thaw lakes on Seward Peninsula (7) have been ascribed to this type of erosion.

From these observations it is concluded that waves generated in summer by strong upriver winds are an effective erosive agent on the north bank of the river and accelerate the northward migration of the Yukon River in the Yukon Flats.

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Crystalline Visnagan

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Khellin, a crystalline dimethoxymethylfurochromone obtained from the seeds (khella) of Ammi visnaga L. (bishop's-weed), has attracted attention because of its vasodilatory activity (1).

The "visnagan" fraction, which is obtained as a more ether-soluble by-product in the preparation of khellin, was described by Samaan (2) as a dark, oily liquid distilling at 160° at 20 mm, with decomposition. In a recent communication, Cavallito and Rockwell (3) reported the isolation of a glassy product from this fraction by fractional precipitation from ether with Skellysolve B (petroleum naphtha) followed by chromatography on silica. For this glassy product they reported the following analytical data: Probable formula: C22H26-28O7; molecular weight: found 387, calcd 402-404; specific rotation, [a]n + 30.5°. Pharmacologically, this product was found to be about twice as active as khellin when tested on the isolated heart.

Although khellin is a useful and potent vasodilator, any product having greater potency with fewer side effects would be a valuable adjunct to the series of compounds used for the treatment of angina pectoris. A program designed to obtain pure principles from the amorphous fraction of extracts was therefore started in these laboratories.

In addition to the isolation of the above-described material, Cavallito and Rockwell described the separation of a product identified as a "crystalline impurity" possessing the following properties: mp, 133°-140°; empirical formula, C15H12O5; molecular weight, 272.

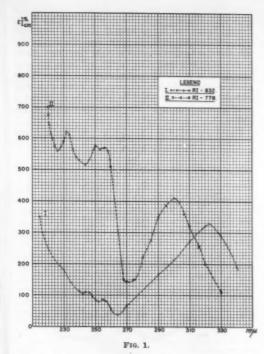
Applying the general method of Cavallito and Rockwell, we chromatographed an extract of khella (RI-811) from which khellin and chellolglycoside had been removed and which was optically active ([a]D+ 5°). Its vasodilatory effect was about two and one half times that of khellin (Table 1). Optical activity

TABLE 1 FLOW INCREASE ON ISOLATED RABBIT HEART IN COMPARISON WITH KHELLIN

Com-	Concen-	Flo	vw	Flow in-	Po-	
pound	tration	Control	Test	erease (%)	tency	
Standard	1: 60,000	26.5	37	40	1	
RI-811	1: 150,000	30.7	43	41	2.5	
Standard	1: 30,000	28.5	42	48	1	
RI-832	1: 240,000	25.9	40	55	8	
Standard	1:30,000	29.5	42.7	44.9	8	
RI-832-3	1: 240,000	27.1	37.3	37.6	8	
Standard	1:30,000	32.4	46.3	42.9	1	
RI-778-3	1: 30,000	29.9	41.5	38.9	1	

and ultraviolet absorption characteristics were emploved as a guide in selecting eluted fractions. Optical activity was read on 0.5% solutions in 95% ethyl alcohol. We thus obtained an amorphous product possessing a specific rotation of [a]D+16° and additional fractions increasing in optical activity to [a]D+50°. From this preliminary separation we subsequently obtained the two crystalline compounds described below.

The eluate ($[\alpha]_D + 16^\circ$) possessed the absorption spectrum described by Cavallito and Rockwell for their amorphous visnagan and had a strong dilating action on the isolated rabbit heart. We rechromatographed this fraction, discarded the first eluate, and obtained a central fraction which, on trituration with methyl alcohol, crystallized after prolonged standing at 4° C. The crystalline visnagan (RI-832), after repeated recrystallization from methanol, had a melting point of 86°-88° and a specific rotation of [a]D+12.5°. The ultraviolet absorption spectrum



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given in Fig. 1 is similar to the curve obtained by Cavallito and Rockwell. Anal: C, 66.84%; H, 7.28% (calcd for C₂₁H₂₈O₆: C, 66.98%; H, 7.50%). Its molecular weight, determined cryoscopically, is 373 (caled, 376.45).

Insofar as we are aware, this is the first description of the isolation of a crystalline compound from the amorphous visnagan fraction of khella extracts that has the ultraviolet absorption properties of the main amorphous product. Three preparations of the compound (RI-832) have been made, two of which have been tested by the Hazleton Laboratories, of Falls Church, Va., in isolated rabbit hearts and found to possess a vasodilating effect approximately eight times that of khellin (Table 1, RI-832 and RI-832-3).

The eluate having the specific rotation $[a]_D + 50^\circ$ also yielded a crystalline compound (RI-778), melting point, 157°-159°, and [a]D+96° after repeated recrystallization from ethyl acetate. Anal: C, 65.15%; H, 5.80% (calcd for C₁₅H₁₆O₅: C, 65.20%; H, 5.84%). The molecular weight by cryoscopic method was found to be 276 (calcd, 276.28). The ultraviolet absorption spectrum of this substance is given in

This compound may correspond to the "crystalline impurity" of Cavallito and Rockwell, since it also yields a hydrochloride with ethereal hydrochloric acid. The hydrochloride is markedly different from the

¹ Microanalyses by Schwarzkopf Microanalytical Laboratory, Middle Village, L. I., N. Y.

oxonium salt of khellin or visnagin in being readily soluble in excess ether. The ultraviolet absorption closely resembles the absorption spectrum reported by Davies and Norris (4) for dihydrokhellin. The basic structure of the compound seems, therefore, to be a dihydrofuranochromone. Its vasodilatory activity is given in Table 1.

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Association of Enzymatic Activity with Submicroscopic Particles

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Considerable study of the mitochondrial fraction of tissues has shown that these particulates possess the major portion of the activity of a number of tissue enzyme systems (1). Although preparations of submicroscopic particles (microsomes) have been found to possess a few enzyme activities in relatively high concentration, previous studies (1) have not indicated exclusive localization of an enzymatic activity in these particles. In the course of investigations on the hydrolysis of triacetic acid lactone by rat kidney homogenates, it was noted that almost all the lactonase activity could be sedimented at $18,000 \times g$ (2). Fractionation according to the methods of Schneider (3) and Schneider and Hogeboom (4) indicated that about 70% of this activity was associated with the submicroscopic particles, whereas the mitochondrial frac-

TABLE 1 INTRACELLULAR DISTRIBUTION OF TRIACETIC ACID LACTONASE IN RAT KIDNEY

		Tilman 1	1.00	TP	04	
		Expt. 1		Expt. 2†		
Fraction	Activity	Percentage	Activity:	Percentage	Activity: Nitrogen	
Whole homogenate	8,95	(100)	7.94	(100)	0.164	
Nuclei + whole cells	1.66	18.5	1.55	19.5	.139	
Mitochondria Submicroscopie	.667	7.5	.474	6.0	.054	
particles	6.34	70.9	5.55	70.0	.607	
Supernatant	1.00	11.2	.700	8.8	0.040	
Sum of fractions	9.67	108	8.27	104	-	

• Fractionated by the procedure of Schneider (8). † Fractionated by the procedure of Schneider and Hoge-boom (4) using 0.25 M sucrose. Activity expressed in terms of the rate constant, k × 10°

k × 100/mg nitrogen.

tion possessed approximately 7% of the total activity (Table 1). Since the slight activity of the mitochondrial and supernatant fractions can probably be attributed to contamination by submicroscopic particles, the data suggest that the lactonase activity is an exclusive function of microsomes. It is possible that other systems may also be entirely localized in these tissue particles (see, for example, 6, 7).

The present data, which were obtained in the course of investigations on polyketo acids, are presented in the belief that they may be of interest to those concerned with the study of cellular particulates. The finding of localization of enzymatic activity in the submicroscopic particle fraction should be considered in the light of the suggestion (8) that these submicroscopic particles are formed as a result of mitochondrial disintegration.

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Membrane Resistance Changes in the Course of Axonal Spikes Modified by Low Na⁺ Concentration¹

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The size, duration and propagation velocity of the axonal spike are known to be altered by changing the environmental Na+ concentration (1). This means of reversibly altering the properties of the spike affords an opportunity to study the course of the correlated resistance changes of the excitable membrane during activity of the nerve fiber.

The resistance change was measured on cleaned giant axons of the squid (Loligo pealii) essentially as was done by Cole and Curtis (2). Transversely oriented external Ag-AgCl electrodes, although not as satisfactory as the platinum-platinum black electrodes of Cole and Curtis, were used. The measuring electrodes were slightly misaligned. Therefore, in addition to the a-e bridge signal, they also recorded a derivative of the spike. It was deemed desirable to carry out all the measurements at room temperature

¹ This work was carried out at the Marine Biological Lab-Woods Hole, Mass., partly under a grant to one of d.) from the U. S. Atomic Energy Commission under contract AT (30-1)-1076.

(25°-26° C), at which the axons nevertheless remained functional for as long as 5 hr. At these high temperatures the spike is brief, and the a-c bridge was therefore supplied with a 25-ke sine wave input, to provide good resolution of the resistance changes. The detector was a differential amplifier flat to 50 kc (6 db down at 150 ke), driving one beam of a dual cathode-ray oscillograph. The second beam carried a simultaneous record of the first differential of the spike.

Fig. 1 illustrates the membrane resistance changes



FIG. 1. The resistance changes of the active axonal membrane in relation to modifications of the spike form produced by altering the external Na* concentration. The first 4 traces represent resistance measurements in sea water, in artificial sea water containing only 60% and 40% Na*, and again in sea water. The lowest record shows the diphasic spike recorded in sea water and at low amplification from electrodes on each side of the impedance measuring pair. A 25-kc signal is superimposed. The initial base lines of the upper 4 records show that the a-c Wheatstone bridge was balanced for the show that the a-c wherestone oringe was balanced for the resting nerve fiber. After the stimulus artifact (lasting approx 70 µsec) and the electrotonic potential, there is seen the onset of the propagated spike. Before this has reached its crest, the membrane resistance falls, and the resulting bridge imbalance is signalized by the appearance of the 25-kc carrier. The maximum resistance changes from above down. carrier. The maximum resistance changes from above downward are 3.2%, 2.1%, 2%, and 2.7%.

observed during activity of one axon, successively bathed in sea water or in artificial sea water in which 40% or 60% of the NaCl had been replaced by choline chloride. Despite the slower, smaller, and broader spikes in the Na+ poor media the onset of the resistance change occurs in the same phase of the spike-namely, approximately at the maximum of the first differential of the latter. The shift occurs rapidly and reversibly on changing the bathing medium. The greatest changes measured with our cell were approximately 3% of the total resistance. This value, of course, represents the much greater fall of the membrane resistance, shunted by the invariant low resistance of the fluid. Cole and Curtis obtained for the same measurement values as high as 7%, but their higher values can be ascribed to the smaller amount of shunting fluid in the measuring cells used by them. A few experiments using oil as the bathing medium gave much higher values. The resistance changes were largest for sea water and progressively smaller, but reversibly so, for the progressively Na* poorer solutions. On the other hand, there was a steady decrease of the amount of the measured resistance change with time.

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The experiments reported here indicate that the membrane resistance change is a consequence of other events in the axonal membrane. They also constitute a further demonstration of the importance of the Na⁺ component of the local circuit, first because the correlated temporal courses of the spike and of the resistance change are both functions of the external Na⁺ concentration and, second, because of the magnitudes of both the spike and of the resistance change are also functions of the external Na⁺ concentration. The latter correlation is of special importance to theoretical concepts of the processes involved in excitation and propagation.

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Blood Transfusion in Irradiation Hemorrhage¹

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Among the postirradiation findings characteristic of near-lethal ($\mathrm{LD}_{50}\mathrm{-LD}_{100}$) exposures to ionizing radiation are spontaneous abnormal bleeding and anemia. Because of the prominence of thrombocytopenia and anemia in the abnormal bleeding syndrome of irradiation sickness, it is natural to assume that the frequent administration of fresh whole blood transfusions might be of considerable therapeutic value in the control or prevention of this type of hemorrhage. In spite of the logical nature of this anticipation, there are no experimental or clinical data to support the contention that blood transfusions will be of value in irradiation injury other than in the treatment of initial shock or in the prevention of

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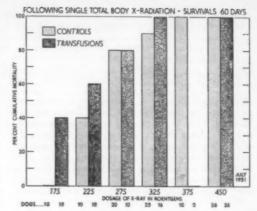


Fig. 1. Cumulative mortality in transfused and nontransfused dogs after exposure to x-radiation.

anemia. Since no American doctor entered either Hiroshima or Nagasaki short of 4 weeks after the bombing, early laboratory data from these disasters are, for all practical purposes, nonexistent. In the absence of human data, our only recourse is to establish the pathologic picture and a therapeutic program based on observations carried out on the experimental animal.

This is a study of the therapeutic value of blood transfusion given, without antibiotics, to determine whether this procedure will prevent irradiation hemorrhage and/or improve the survival rate in the x-irradiated dog. The dog was chosen because in many respects its response to total-body irradiation is similar to man. This animal differs in one important respect in that its blood types are much less well defined. As seen below, the results obtained from transfusion alone are the reverse of those anticipated.

One hundred and seventy-three dogs were exposed to single doses of total-body x-irradiation at the following dosage levels: 175, 225, 275, 325, 375, and 450 r. The animals were divided into two groups; one group of 101 dogs served as controls, and the other group of 72 was transfused with citrated fresh whole blood 3 times a week beginning on the fourth post-irradiation day. Five ml/kg of body weight was administered on each day the animal was transfused. In addition to this blood the animal also received a volume of blood equivalent to the amount withdrawn for study just prior to each transfusion. No other treatment was administered.

For comparative purposes the experiment was so arranged that animals receiving blood were paired with control animals of approximately the same size, which were irradiated under similar conditions on the same day. All were mongrels, and both male and female dogs were used.

Total-body exposures were administered, placing the unanesthetized dog in a canvas sling suspended before the energy source, a GE Maximar 250-kv,

TABLE 1
AVERAGE POSTIRRADIATION LIFE OF THE NONSURVIVALS

	450 r	375 r	325 r	275 r	225 r	175 r
Controls	10.4 days	13.3 days	11.7 days	16.4 days	17.2 days	All survived
Transfusions	9.7	None studied	11.8 ''	17.8 ''	18.1	22.5 days

15-ma x-ray machine. A combination 1-mm copper and 3-mm bakelite filter was used. The target distance was 57 in. to the projected center of the animal, and the average rate of delivery was 5.12 r/min. To achieve a given dosage level, exposure time was adjusted accordingly. All other physical factors were constant. In each instance one half the total dose was delivered from one side, then the animal was rotated 180° within its sling and the exposure was completed.

The following studies were conducted for both control and transfused animals: (1) the whole blood clotting time; (2) the Quick one-step prothrombin time; (3) the erythrocyte, leucocyte, and thrombocyte counts, and hemoglobin determinations; (4) weight records 3 times/week; and (5) daily rectal temperatures.

All bloods were cross-matched prior to transfusion. Autopsies were performed on 95% of the transfused dogs and on 91% of the controls. The incidence and site of hemorrhage at autopsy were classified according to the organs and tissues in which bleeding occurred.

Fig. 1 demonstrates that citrated whole blood transfusions, alone and under these conditions, did not increase survival over that of the controls. Table 1 shows the average postirradiation life of the non-

TABLE 2

LOCATION AND FREQUENCY OF GROSS HEMORRHAGE
IN CERTAIN AREAS IN X-IRRADIATED DOGS

Location of hemorrhage	Frequency in 69 control dogs*	Frequency in 53 transfused dogs†
	(%)	(%)
Skin (other than venepunc-		
ture sites)	28	21
Gingiva	50	38
Chest		
Parietal pleura	69	66
Mediastinum	43	48
Lungs		
Hilar hemorrhage	49	46
Pneumonia	82	88
Heart		
Pericardium	53	58
Epicardium	66	73
Diaphragm	27	23
Abdomen		
Retroperitoneal	26	34
Stomach	52	46
Intestine	77	67
Colon	61	51
Kidneys	25	37
Bladder	32	34

^{*} Sixty-nine autopsies done, 10 not done, 22 survivors. † Fifty-three autopsies done, 7 not done, 12 survivors.

survivals of controls and transfused animals at the exposure levels used.

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Table 2 indicates that gross hemorrhages found in certain organs and tissues at autopsy were as frequent in the transfused irradiated dogs as in the untreated controls. Sixteen other hemorrhagic sites, showing similar data, are excluded from Table 2 in the interest of brevity.

No significant or consistent drop in prothrombin activity in either the transfused animals or their controls was apparent, and, as illustrated in Fig. 2,

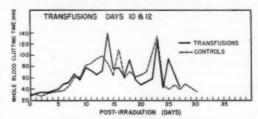


Fig. 2. Average whole blood clotting time in transfused and control dogs following radiation.

transfusion alone failed to prevent or control the postirradiation increase in the whole blood clotting time.

Fig. 3 shows the failure of blood transfusion to prevent or correct postirradiation thrombocytopenia or leucopenia. The only benefit observed in blood transfusion was that it prevented the full extent of irradiation anemia (Fig. 4).

There was no consistent difference between the two groups in febrile response or in weight loss characteristic of postirradiation sickness.

These data indicate that blood transfusion without

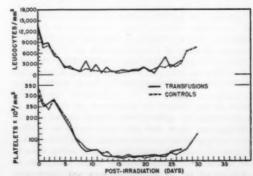
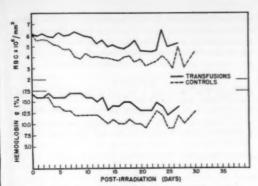


Fig. 3. Average platelet and leucocyte counts of transfused and control dogs following radiation.



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Fig. 4. Average erythrocyte count and hemoglobin of transfused and control dogs following radiation.

antibiotics under the experimental conditions described here is of no benefit either in preventing or in treating irradiation hemorrhage, in lessening the changes in coagulation for untreated animals, or in improving survival rate or time. In some animals the bleeding actually increased in severity after transfusion, and this was accompanied by a further increase in the whole blood clotting time. Moreover, if the numbers of animals can be considered sufficient to decide the influence of transfusion upon survival rate and time, it can only be concluded that transfusion was deleterious.

Some of the animals displayed symptoms of transfusion reactions, as reported previously (1). It is possible that others also had mild reactions that were not clinically detectable. Transfusion reactions in the nonirradiated dog are remarkably rare, whereas after irradiation they occur with sufficient frequency to present a definite risk. The reactions noted were anaphylactoid in nature. Alterations in the clotting time and in the protamine titration, when they resulted from the transfusion reaction, were overcome by the administration of protamine sulfate or toluidine blue (1). Bleeding from ulcerated areas, the continued formation of petechiae, and the hemorrhagic gastroenteritis, however, were not influenced by these agents.

Endogenous heparinemia is characteristic of anaphylactoid reactions (2) and may be associated with blood transfusions which also are anaphylactoid in character. The recent reports of Muirhead (3) and of Friesen, Harsha, and McCroskey (4) are of great interest. These two groups reported that the abnormal bleeding during or following surgery often was the result of minor or major incompatibility of transfused blood. In each instance where this was recognized prompt cessation of bleeding was associated with the administration of toluidine blue or protamine sulfate. We have repeatedly observed and reported the same findings.

The University of Kansas group was also able to reproduce the type of bleeding described above by the repeated transfusion of blood in pure-bred Boxer

dogs (4). In 4 of 6 animals so afflicted, death resulted from spontaneous hemorrhage before antiheparins could be given.

If man, like the dog, is more susceptible to transfusion reactions following irradiation injury, when he already is bleeding from thrombocytopenia, capillary injury, and ulcerative alimentary lesions, the administration of whole blood transfusion should not be attempted unless protamine sulfate or toluidine blue is available in case transfusion reactions occur and increase the bleeding tendency.

The one beneficial effect of blood transfusion that is brought out by these experiments is the correction of anemia, provided sufficient quantities of blood are administered. If these data can be applied to man under similar circumstances, 300-500 ml of blood, given 3 times per week starting on the fourth day, should be sufficient to maintain the erythrocyte count above 3,500,000/cm3 and hemoglobin concentrations above 10 g%. It is clearly apparent, however, that the postirradiation anemia in the dogs is of little, if any, consequence in determining their fate or rate of survival. Our observations should not discourage the use of blood with other therapy in irradiation injury, since our animals died before they developed a profound anemia, and these data in no way question the need of blood transfusion in the treatment of anemic anoxia.

The data herein presented do not take into account the possibility that blood transfusion combined with antibiotic and/or other therapy may prove beneficial. In a previous report (1) it was observed that blood transfusion combined with daily administration of aureomycin enabled 2 of 11 dogs to survive a 450 r total-body x-radiation, whereas 14 similarly irradiated dogs receiving only aureomycin, on the same schedule, died. Animals receiving blood transfusion together with aureomycin fared better than those receiving aureomycin alone. Irradiation hemorrhage was not noticeably reduced in either case. Considerably more data are necessary, however, before the effect of blood transfusions combined with antibiotic therapy can be evaluated. Studies of this nature that are currently under way appear more hopeful.

These experiments clearly indicate that the frequent transfusion of blood without antibioties is futile in the treatment or prevention of irradiation hemorrhage in dogs and that it gives no evidence of increasing survival rate or time. It does not follow that man, similarly exposed to ionizing irradiation, would not benefit from frequent transfusion, because the status of blood types and transfusions in dogs is ill defined and may not be appropriate for human comparison. On the other hand, it could prove disastrous to depend on blood transfusion to control irradiation hemorrhage in man, should the response in the irradiated human patient to blood transfusion be similar to that in dogs. Further experience with transfusions given dogs and other species, especially some of the subhuman primates, is urgently needed. If blood transfusion appears to offer little hope in controlling irradiation hemorrhage in man, this knowledge would afford a more intelligent basis for the use of blood and would channel the limited supply available in the directions in which it may be used most effectively.

The frequent administration of fresh blood transfusions without antibiotics in dogs failed to improve the survival rate or to ameliorate spontaneous bleeding after exposures to total body x-radiation (LD50-LD100). On the basis of these experiments a more cautious attitude toward the use of frequent blood transfusion alone as a therapeutic measure in the treatment of the latent symptoms of irradiation injury in man may be indicated. These data do not relate in any manner to the use of blood in the treatment of shock incident to the early blast effects of an atomic burst, or to blood needs in anoxic anemia, where the therapeutic importance of adequate blood and plasma transfusion is soundly established.

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Comments and Communications

Some Punkins!

Dr. ZACKS' statistical note on "How Does the Ivy Grow?" in Science (114, 332 [1951]), with a later correction (114, 469 [1951]), is interesting, but either Harvard ivy is a laggard as regards its rate of growth, or else the fertility of Boston soil falls far short of that in the garden of a member of the University of Missouri faculty, as these records will show.

A single stray pie-pumpkin seed was found sprouting in a row of garden beets on May 17, 1951, and the plant was permitted to "root for itself" until killing frosts laid it low while still in the vigor of life on November 5, 1951. The plant received no added fertilizer and no cultivation or other care, except that some of the more ambitious runners were turned back into the garden from a traveled city alley at the edge of the garden. In all fairness, however, it should be said that there were no squash bugs in the garden to pester it.

In the 173 days, or 249,120 minutes, of its active life the plant produced a total over-all vine growth of 1986 ft, or 605,332.8 mm. This would mean a total average vine growth of 2.43 mm/min. However, this is a measure of total vine growth and not of the tip growth of any one runner. The longest single branch measured slightly over 75 ft, or 22,860 mm, which means that this vine made an average tip growth throughout the summer, rain or shine, of .092 mm/ min. Observations showed that at the peak of growth it was greatly exceeding this record. In other words, this vine made an average daily growth of over 5 in., so one could actually see it grow.

But that is not all. While growing almost twice as fast as the ivy, this vine also produced 20 pumpkins weighing a total of 300 pounds, besides several small immature ones. In kitchen parlance this means that the vine produced one pumpkin pie every 7 hr. It overran every growing thing, including a grape arbor, fruit trees, and flowers, in 1600 square feet of garden space. Some of its leaves were 15 in. across. And yet

the whole story of this waif of a pumpkin seed has not been told, for during its remarkable vegetative growth and its production of the makings of over 500 pies, the seed actually reproduced itself twenty thousandfold, for the 20 mature pumpkins contained an average of 1000 seeds each. To my way of thinking, the Harvard ivy, with no serious accomplishments to its credit other than tip growth and perhaps a few seeds, really made a poor showing.

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The Alleged Disappearance of Hunger During Starvation

KEYS et al. (1) stated that the sensation of hunger disappears in a matter of days during total starvation, but that no diminution of hunger occurred during a type of semistarvation studied by them. Cannon (2,3) seems to have been mainly responsible for the persistence of claims that hunger sensations cease after the first few days of starvation, although he made no study of hunger during prolonged starvation. Cannon only cited reports made by others, including hunger-strikers and individuals who tried the fasting cure (4). One of us (F. H.), after having fasted 8 days in 1912 and 26 days in 1913, also believed that the reference of hunger to the stomach disappeared in 5 or 6 days. In 1916, he thought that the senior author's study during 5 days of starvation (5,6) was not sufficiently prolonged to reveal the true nature of hunger. Hence, a study of hunger was made by the senior author in which the junior author served as the subject during a 15-day fast in 1917 (7).

It was found that the periodic gastric contractions, which Cannon as well as the senior author attributed to hunger, persisted throughout the 15 days of fasting, and that the desire to eat or to resume eating was always keenest when the periodic gastric contractions occurred. A modification of the sensations was experienced after about the sixth day of starvation, but this was regarded as involving a depression of appetite rather than hunger. Cannon did not appear to distinguish between hunger and appetite in connection with prolonged starvation.

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In further studies of the effect of fasting 10-41 days by human subjects (8-11), it was found that hunger persisted throughout the fasts, whether it was considered as the pangs produced by the periodic gastric contractions or as a centrally produced impulse to eat (12). The kymographic record of a period of gastric hunger contractions obtained on the fortieth day of fasting was published in 1927 (9), and data concerning the periodic gastric motor and secretory activity obtained without the use of an inflated balloon in the stomach, as well as data regarding sensations experienced during fasts of 33 and 41 days, were published in 1944 (11). In dogs and rabbits, the periodic gastric hunger contractions were likewise found to persist during prolonged starvation (5,6). Some rats, after fasts of 15-25 days, were so voraeious that they died, apparently from overeating, within a few hours after being supplied with food (13). Their stomachs were greatly distended with food, but evidently little was digested and absorbed. Hibernating animals resume eating after prolonged abstinence from food, presumably because of hunger.

In man, hunger sensations nevertheless usually appear to become modified or less acute after the first few days of fasting. The complete disappearance of hunger in some hunger-strikers and sick individuals who resort to the fasting cure cannot be regarded as normal. Observations made by the junior author (14) indicated that the acute hunger sensations experienced during the first few days of fasting after living on a mixed or high carbohydrate diet are chiefly due to carbohydrate starvation or a lack of adaptation to living on a purely carnivorous diet, such as one actually lives on while fasting. Evidence that hunger is influenced considerably by carbohydrate starvation or the blood sugar level was previously obtained by Bulatao and Carlson (15) in a study on dogs, and more recently by Mayer and Bates (16) in a study

Hoelzel (11) also found that the contractions of the fasting stomach were felt only when the contents of the stomach were less than about 5 cc, and that the emptying of the fasting stomach became complicated by increasing reverse peristalsis or regurgitation of the duodenal contents after the first few days of fasting. Under such circumstances, gastric pangs of hunger were not felt, but the desire to eat was experienced, with increased restlessness, general weakness, and, eventually, some degree of nausea. Janowitz and Grossman (17) apparently did not regard such "hunger sensations" as related to the periodic fasting gastrointestinal activity. Hunger, or the desire, impulse, or drive to resume eating, normally increases again after the initial acute sensations decrease. Advocates of the fasting cure regard the return of hunger (normal, natural, or instinctive hunger) after the early disappearance of "hunger" ("habit-hunger" or "false appetite") as evidence that health has been restored by fasting and that eating should be resumed. The normally increasing desire to resume eating or the return of hunger with the prolongation of fasting appears to be mainly due to protein starvation. Protein starvation alone was found to give rise to the most acute type of epigastric hunger sensation (11). In rats and mice protein starvation produced peptic ulcers (13). In short, hunger in some form normally seems to persist about as long as life is maintained.

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Escherichia coli in the Intestine of a Wild Sea Lion¹

LITTLE literature is available concerning the presence of Escherichia coli in the intestinal tract of marine mammals. Coliforms have been found in polar bears (1) but were not confirmed to be E. coli. ZoBell (2) states that E. coli does not appear to be a normal inhabitant of the intestines of seals in captivity. Recent work by the authors, however, suggests that E. coli is commonly found in the intestines of captive seals maintained in either fresh or sea water. This organism is a very common contaminant of stored marine fish (2) and may be introduced into the seal's alimentary system by the feeding of such material. Therefore, when a wild sea lion (Zalophus californianus) was captured near the Scripps Institution of Oceanography, an attempt was made to determine whether E. coli might be present under natural con-

The specimen, an adult female, was sacrificed, and samples were removed aseptically from the stomach and from the initial, central, and terminal sections of

¹ Contribution from the Scripps Institution of Oceanography, New Series No. 559.

the intestines. Difco Levine EMB agar, prepared both with fresh and with sea water, was used as the isolating medium. The medium was poured into plates and streaked with the samples from the sea lion.

After 24 hr incubation, at both 27° and 37° C, the EMB plates were examined, and the presence of coliform organisms was established in both the lower end of the small intestine and in the entire large intestine. The stomach appeared to be sterile. Typical coliform organisms appeared on the sea-water medium, but the colonies on fresh-water medium lacked their differentiating metallic sheen. All other features, including routine differential media, indicated that the organisms were E. coli. The isolated E. coli cultures grew as well, at either 27° or 37° C, on sea-water as they did on fresh-water medium; hence these organisms may have been indigenous to the sea or were more resistant forms from terrestrial contamination. E. coli will normally tolerate limited exposure to sea water, but the conventionally known strains are reportedly either killed quantitatively or diluted to virtual extinction by sea water in full strength (2).

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Autohemagglutinins in the Serum of Patients with Acute Lupus Erythematosus

A RECENT note by Schleicher (1) described a test for acute lupus erythematosus, in which Group O Rh-positive erythrocytes were agglutinated by the patient's serum in a saline solution of egg albumin. The agglutination disappeared at room temperature

and at 37° C but reappeared at refrigerator temperatures.

Fjelde (2), using a modification of Schleicher's procedure, has reported detecting the erythrocyte aggregation factor in the serum of 17 out of 17 patients with the acute form of lupus erythematosus. The factor was not identified.

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The similarity of the tests used by Schleicher and Fjelde to those usually employed to detect autohemagglutinins in the serum of patients presenting primary atypical pneumonia syndromes, hemolytic syndromes, and occasional other disorders (3) prompted us to investigate the matter further. In addition, we had previously noted that autohemagglutinins active at refrigerator temperatures were frequently present in the serum of patients suffering from acute lupus erythematosus.

Samples of blood were obtained from 7 patients with acute disseminated lupus erythematosus, 2 with noncongenital hemolytic syndromes, 3 with miscellaneous disorders—including 1 patient with pneumonitis presumed to be of viral origin—and 20 persons whose serum did not contain autohemagglutinins.

The method used in our laboratory seldom gives positive results with serum from normal persons; it consists of serial dilutions of serum in 0.9% sodium chloride solution, ranging from 1:4 through 1:2048, to which is added 0.1 ml 2% suspension of washed O Rh-positive erythrocytes. The tubes are refrigerated overnight and examined for the presence of agglutination. The foregoing test was performed on samples of serum from all the cases. Venous blood was allowed to clot at room temperature, and the serum was removed and used at once, or was frozen for use in the near future.

The method described by Schleicher was also used on duplicate samples and at the same time. To 1 ml refrigerated 10% egg albumin in 0.9% sodium chloride solution, 0.5 ml serum was added, and the fluids were mixed. One drop (0.05 ml) of a 10% suspen-

TABLE 1 RESULTS OF TESTS

Case	Clinical diagnosis	Cold agglutinin titer	Schleicher test	Schleicher test after absorption with O Rh derythrocyte in the cold
1	Acute lupus erythematosus with hemolytic anemia	1:8	+	
2		1:32	+	Negative
3	Subacute lupus erythematosus	Negative	Negative	
4	44 44 16	4.6	31	
5	Acute lupus erythematosus	1:8	4	4.4
6	66 66 66	1:16	+	6.6
7	66 66 66	1:16	4	4.4
8	Noncongenital hemolytic syndrome	1:8	4	
9	11 11	1:32	4	6.6
10	Hyperglobulinemia with multiple serologic			44
	abnormalities	1:8	4	
11	Acute leukemia with indeterminate lesion in lung	1:16	4	
12	Pneumonitis	1: 32	4	
13-32	Normal controls	Negative	Negative	

sion of washed cold O Rh-positive erythrocytes was added to each tube. The tubes were kept at refrigerator temperature for 30 min, centrifuged at 1000 rpm for 1 min, and examined for agglutination. Besides the negative serum controls, we found it useful to prepare an albumin solution control of 1 ml albumin solution, 0.5 ml saline, and 0.05 ml of the cell suspension. It was found that the albumin solution could be frozen in small amounts, thus obviating the necessity of preparing a fresh solution the day before each test. It was also found that a 10% suspension of O Rh-positive cells could be prepared the day of the test, if the final dilution was made up in refrigerated saline.

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All the serums that gave positive results with a titer of 1:8 or greater with our standard "cold agglutination" test also gave strongly positive results with the Schleicher method. These included 5 of the 7 cases of acute lupus erythematosus. All the serums that gave negative results with our standard agglutination tests also gave negative results with the Schleicher method (Table 1).

Absorption tests were performed on most of the positive serums in order to identify the erythrocyte aggregation factor of Schleicher and Fjelde as a cold agglutinin. The tests were performed by adding 25% by volume of packed washed O Rh-positive erythrocytes to samples of serum and allowing the mixtures to stand for 4 hr in the refrigerator. The supernatant serum was then removed, and both standard and Schleicher tests were performed on the absorbed serum and on corresponding untreated serums that had been allowed to stand simultaneously in the refrigerator. The absorbed serums all gave negative results with both tests, whereas their corresponding serum controls gave positive results by both methods. Negative controls were included with all tests.

Additional evidence that the autohemagglutinin detected by the standard method is similar to that shown by the albumin method was found when some of the positive serums were retested after several weeks in the frozen state. The results were commonly weak or negative. It is known that cold agglutinins often decrease in titer with storage, even when

We conclude that the aggregation factor in the serum of patients with acute lupus erythematosus described by Schleicher and Fjelde is similar to, or identical with, the cold agglutinin frequently observed in patients with primary atypical pneumonia syndromes, acute hemolytic syndromes, and certain other conditions.

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Microbiological Conversion of Pregnenolone to Progesterone

THE conversion of pregnenolone to progesterone by the bacterium Corynebacterium mediolanum has been reported by Mamoli (Ber., 71, 2701 [1938]). More recently the same oxidation has been observed in liver slices and other tissues by Samuels et al. (SCIENCE, 113, 390 [1951]). We have found that other microorganisms, including actinomycetes and molds, are capable of carrying out this oxidation. In our studies, a group of species of streptomyces, including Streptomyces griseus, S. fradiae, S. aureofaciens, and S. rimosus, were grown in submerged aerated culture (100 ml medium/500-ml flask) on a soybean meal-glucose-soybean oil medium, to which was added 20 mg/100 ml of pregnenolone. After 24 hr incubation the fermentations were extracted thrice with an equal volume of chloroform. The extracts were pooled, and aliquots examined by Zaffaroni's filter-paper partition chromatographic technique (SCIENCE, 111, 6 [1950]), using the toluene-propylene glycol system. The steroid located on one of a number of replicate strips using the Zimmerman reagent, following a 1-hr development period, had a mobility equal to that of a progesterone standard. The steriodcontaining areas of other strips were eluted with ethanol, pooled, and identified by the procedures used by Samuels et al. (loc. cit.)-i.e., measurement of absorption spectrum of the steroid and of its dinitrophenylhydrazone derivative. The steroid in these ethanol eluates had an absorption maximum at 240 mu, which might be explained by oxidation of the 3hydroxyl group to a keto group, accompanied by a shift of the 5, 6 double bond to the 4, 5 position. Pregnenolone has no absorption maximum at 240 mm. The dinitrophenylhydrazone derivative of the steroid in the ethanol eluates had an absorption spectrum similar to that obtained with progesterone bisdinitrophenylhydrazone. These data, together with the mobility in the filter-paper chromatographic system and the absorption spectrum of the steroid, suggest that progesterone was present in the chloroform extracts of the fermentations.

A similar series of fermentations was carried out, using Phycomyces blakesleeanus, Aspergillus niger, Penicillium chrysogenum, Eremothecium ashbyii, and Ustilago seae cultures grown in submerged aerated culture on a cornsteep liquor-calcium carbonateglucose-soybean oil medium supplemented with pregnenolone at a level of 20 mg/100 ml. The steroid recovered in the chloroform extracts of these cultures had the same characteristics as those found in the extracts of the actinomycete cultures. These experiments indicate that actinomycetes and molds are able to earry out the biological oxidation of pregnenolone to progesterone, first observed by Mamoli, who used bacteria, and more recently by Samuels et al., who used liver and other tissue preparations.

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Book Reviews

Essay in Physics. Herbert L. Samuel. New York: Harcourt, Brace, 1952. 178 pp. \$3.00.

This book was first printed in England in February 1951, with a preface dated November 1950. The American edition includes an additional section on the theory of the expanding universe with an author's

note dated August 1951.

The author is president of the Royal Institute of Philosophy, and throughout the book he makes a sharp distinction between the point of view of the philosopher and that of the physicist. The latter appears to him superficial in the sense that the physicist is not interested in "reality" or "fundamental causes" or "explanations" and is satisfied with descriptions of experience and with theories formulated in purely mathematical terms. The philosophers, on the other hand.

... try to keep their eye on the processes of nature themselves and will not be content with their inter-measurements... they persist in seeking the "'real essence' through a search for causes... it is in this realm (6.0., the realm beyond the range of scientific observation and calculation), if at all, that the solutions to the fundamental problems that are still outstanding are most likely to be found (p. 39).

The book consists of two parts-in the first Lord Samuel expounds the arguments that make him dissatisfied with the achievements of present-day physics. The second part aims to be constructive by presenting a theory or picture of the universe that the author hopes may perhaps eventually be made to satisfy the demands of the philosopher. It is by this second part that the merit of the whole point of view must be judged, and it seems to me that if ever a point of view offered its own refutation, this is it. The fundamental reality is postulated to be energy, which is capable of existing in two forms, one quiescent, the other active. Most phenomena consist in the passage of energy from one form to the other. But if the physicist cannot "explain," to what extent can it be maintained that we have here an explanation? There is no suggestion of the details by which the transfer of energy between the two forms takes place, nor of what differentiates one sort of passage from another. All sorts of ad hoc assumptions have to be made for which there is no correspondence with any independent physical happening, and of which the meaning is predominantly verbal. Lord Samuel seems to have no conception of the nature of the problem of explanation, particularly of explanation in a brandnew field in which the old concepts fail. How can one begin the attack on such a field except by precise description?

One of the greatest mysteries for Lord Samuel is "momentum." He asks what "force" "makes" a body continue to move in a straight line. His discussion of the details of the motion of free bodies moving either horizontally or vertically in the earth's gravitational

field introduces considerations essentially mathematical in character, but his thesis allows the use of none of the formal machinery of mathematics, with the result that even such elementary distinctions as between velocity and acceleration are confused.

His repugnance to mathematics makes him deprecate the precise descriptions of nature made possible by mathematical language, forgetting that the precisions so described are properly to be called discoveries about nature rather than human inventions, and that part of the task of the philosopher becomes the understanding of the precise relationships thus disclosed. The whole point of view and method of attack seem to me essentially a reversion to the Greeks, like the attack of the Greeks almost purely verbal, and perhaps even more sterile in suggesting new ex-

periments or in correlating old ones.

The book concludes with a letter from Einstein, to whom Lord Samuel, a friend of Einstein's of long standing, had sent a copy of the book in proof, in the hope that Einstein would express his opinion. Einstein's letter is courteous and considerate, as would be expected, but the major part of the letter is occupied with seriously setting forth some of Einstein's reasons for not agreeing with Lord Samuel's views about "reality." The letter has its interest in making a little plainer some of the fundamental differences in point of view between Einstein and the majority of contemporary physicists—a disagreement that has been extensively explored in Albert Einstein: Philosopher-Scientist (Science, 111, 409 [1950]), edited by Paul Arthur Schilpp.

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Microbial Decomposition of Cellulose: With Special Reference to Cotton Textiles. R. G. H. Siu. New York: Reinhold, 1951. 531 pp. \$10.00.

The fact that textiles mildew or rot is a familiar one to the housewife, the camper, the cotton grower, and, more recently, to our armed forces operating in tropical areas. The amount of textile materials rendered useless in peacetime cannot be easily determined but is undoubtedly very great. The quantity rendered useless during the war in military operations was staggering. The seriousness of this situation moved the armed forces to seek methods for providing cellulosic textiles with protection from microbial decomposition. In particular, the Quartermaster Corps of the Army, in cooperation with the chemical and textile-finishing industries, began a campaign to find preparations that could be applied to military textiles and considerably extend their field life under storage and combat conditions.

This was the quick, stopgap, empirical, and practical approach. It was partially effective, but was not quite sufficient. The materials used were toxic to the appliers and handlers. They did not always fulfill the requirements under a wide variety of conditions. Tests for effectiveness of treatment were unreliable. It was soon felt that a basic study should be undertaken into the mechanism of microbial decomposition. Thus, the studies represented by this book and so ably reported by its author are the outcome of some seven years of concentrated work by the Quartermaster Tropical Deterioration Laboratory, as well as a thorough coverage of the technical literature.

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A review of the table of contents reveals what would appear to be an ambitious coverage of the factors underlying the complete cycle from the formation of the cellulose molecule to its microbial decomposition. Dr. Siu first describes this eyele as basic to nature's balance. He next describes the structure, physical and chemical features of cotton, materials made from it, and the modification that occurs when it is subjected to various types of textile wet-processing and finishing. This chapter gives an excellent coverage of the subject.

The chapter on causal organisms contains a highly authoritative discussion of the methods of identification, assay, and determination of the nutritional and environmental factors of cellulolytic microorganisms. Materials were obtained from various tropical areas and cellulose-subsisting microorganisms isolated from them. From this extensive group, representative ones were taken for further study into the mechanism of the degradation of cellulose as well as the gross effect on textile materials. This consists of such effects as the staining and discoloration of fabrics, their loss in strength and weight, and the attack on fibers as a whole.

From a scientific point of view, the section on biochemical transformation of cellulose molecules represents the most important contribution the book makes, as it presents a coordinated and complete basic study of the chain of events leading to the breakdown of cellulose by microorganisms. This sequence is not a simple and direct one that explains the action of all microorganisms. However, the author presents a valuable diagram showing the many types of decomposition mechanisms that have been experimentally verified, are probable, or are postulated. In this manner, he has indicated the progress of research and has provided the basis for further study, as well as application of the results.

The principal application of the results, insofar as the textile manufacturer or user is concerned, is that leading to an understanding of the methods of prevention of such degradation. His studies show that this may be accomplished in several ways: killing the invading organism with toxic substances; neutralizing the cellulolytic enzymes by specific enzyme inhibitors; preventing the organism from making the necessary intimate contact with the cellulose through use of an interposed inert physical barrier, such as resin coatings and impregnations; chemically modifying cellulose fibers to give a layer of resistant derivatives on their surface and/or in the more accessible amorphous regions. He then provides a list of requirements for the ideal method, pointing out that no single method has yet been devised that meets all of them. Its inherent properties should be such that it is inhibitory to a wide variety of microorganisms in relatively low concentrations, nontoxic to higher animals and man, reasonable in cost, available in large quantities, nonleachable by rain and water, heat- and light-resistant, noncorrosive to metals, odorless, colorless, and nonvolatile. Its interaction with textile fabrics should show compatibility with dyeing, and water-resistant, flameproofing, and other finishing treatments; should not adversely alter the stiffness, resiliency, elasticity, breaking and tearing strength, air and moisture permeability, water permeability, and other physical properties; should not accelerate chemical tendering of cellulose by dyes, pigments, and other finishing compounds; and should not catalyze the photochemical degradation of cellulose. Its textile processing characteristics should be such as to require relatively simple procedures, no machinery not ordinarily used in textile-finishing plants, no excessive quantities of toxic solvents, no fire hazards during processing, safety in handling and use, and capability of thorough penetration into cotton. Depending upon the use to which the material is to be put, additional requirements may be placed on the method and certain of the above may be minimized.

Effectiveness of treatment requires both laboratory and field testing methods. Dr. Siu discusses at length the details of these methods, as well as the interpretation of their results.

Finally, in a section of primary interest to those interested in specifying the performance characteristics of textiles and in providing the desired microbial protection, he relates various methods that have been tried to effect this protection. Of the three methods (physical barriers, toxic inhibitors, and chemical modification) only the toxic inhibitor method has been extensively used to date. This method has come closest to meeting the extensive requirements for the ideal method. However, there have been many shortcomings in each of the treatments, and the author points out that, at least theoretically, chemical modification shows the greatest possibilities, and he has provided an excellent basis for further investigation along these lines. The principal difficulty associated with this method is the basic one of overcoming the formidable textile production problems.

The author has taken an ancient problem that has been approached empirically in the past and has provided a sound scientific basis for the understanding of the empirical methods as well as the development of methods that may, as applied research progresses, ultimately meet the requirements of the ideal method. This book is a distinct contribution to the

science of textile technology.

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The Sucking Lice. Pacific Coast Entomological Society Memoir, Vol. 1. G. F. Ferris. San Francisco: Pacific Coast Entomological Society, 1951. 320 pp. 86 00

The sucking liee (Anoptura), except for the human species, have been neglected in the past by biologists -despite the many features of general biological import in the adaptations and host associations of these insects, and their potential importance in the transmission and maintenance in nature of reservoirs of pathogenic organisms. The publication of the present volume is particularly timely, for large-scale surveys and ecological studies on the ectoparasites of mammals have been initiated recently. This book, by the recognized world authority on the order, provides for the first time a guide to the identification of all the known species of sucking lice, as well as an introduction to their morphology. Together with the admirable paper of G. H. E. Hopkins on the host associations of the liee of mammals (Proc. Zool. Soc. [London,] 119, 337 [1949]), it should serve as a sound basis for all future biological work on this group.

The extensive chapter on the morphology and anatomy of the Anoptura (47 pp.), based on the original investigations carried out by Chester J. Stojanovich under the direction of Professor Ferris, is of particular interest because it also contains a summary of the author's ideas on insect morphology-ideas often at variance with generally accepted interpretations. This section is profusely illustrated with excellent drawings, and the treatment is generally adequate, although the morphological interpretations do not appear to be always consistent with the anatomical facts. It is unfortunate that the male genitalia were not covered more thoroughly, since they appear to offer clues to the relationships of the various forms and have not been studied comparatively in this group and the related biting lice.

The bulk of the volume (228 pp.) is devoted to a review of the families, subfamilies, genera, and species of the sucking lice of the world and their classification and relationships. This section is based on the taxonomic monographs published by Ferris from 1919 to 1935 (Stanford Univ. Pubs. Biol. Sci., 2), but includes much new material. Not all the proposed changes in the classification will gain recognition, for it is quite apparent that our present knowledge of the sucking lice is insufficient in all respects to develop a natural classification. The keys to subfamilies, genera, and species, and the detailed drawings of a representative of each genus, as well as of all the economically important species, are very important features of the taxonomic section. It is unfortunate that no key to families is given and that no statement of size is made for any species.

Shorter sections on generalities (2 pp.), growth and development (8 pp.), a host list (18 pp.), and distribution (6 pp.) add to the usefulness of the book. It should be of value and interest not only to ento-

mologists, parasitologists, and public health workers, but to all zoologists.

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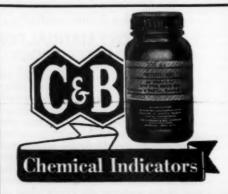
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